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Abstracts in the journal are grouped under the following categories:

page:

01 AERODYNAMICS

Includes aerodynamics of bodies, combinations, internal flow in ducts and turbomachinery; wings, rotors, and control surfaces. For applications see: 02 Aircraft and 31 Space Vehicles. For related information see also: 12 Fluid Mechanics; and 33 Thermodynamics and Combustion. **1391**

02 AIRCRAFT

Includes fixed-wing airplanes, helicopters, gliders, balloons, ornithopters, etc; and specific types of complete aircraft (e.g., ground effect machines, STOL, and VTOL); flight tests; operating problems (e.g., sonic boom); safety and safety devices; economics; and stability and control. For basic research see: 01 Aerodynamics. For related information see also: 31 Space Vehicles; and 32 Structural Mechanics. **1394**

03 AUXILIARY SYSTEMS

Includes fuel cells, energy conversion cells, and solar cells; auxiliary gas turbines; hydraulic, pneumatic and electrical systems; actuators; and inverters. For related information see also: 09 Electronic Equipment; 22 Nuclear Engineering; and 28 Propulsion Systems. **1394**

04 BIOSCIENCES

Includes aerospace medicine, exobiology, radiation effects on biological systems; physiological and psychological factors. For related information see also: 05 Biotechnology. **1397**

05 BIOTECHNOLOGY

Includes life support systems, human engineering; protective clothing and equipment; crew training and evaluation, and piloting. For related information see also: 04 Biosciences. **1403**

06 CHEMISTRY

Includes chemical analysis and identification (e.g., spectroscopy). For applications see: 17 Materials, Metallic; 18 Materials, Nonmetallic; and 27 Propellants. **1405**

07 COMMUNICATIONS

Includes communications equipment and techniques; noise; radio and communications blackout; modulation telemetry; tracking radar and optical observation; and wave propagation. For basic research see: 23 Physics, General; and 21 Navigation. **1414**

08 COMPUTERS

Includes computer operation and programming; and data processing. For basic research see: 19 Mathematics. **1420**

09 ELECTRONIC EQUIPMENT

Includes electronic test equipment and maintainability; component parts, e.g., electron tubes, tunnel diodes, transistors; integrated circuitry; microminiaturization. For basic research see: 10 Electronics. For related information see also: 07 Communications and 21 Navigation. **1423**

10 ELECTRONICS

Includes circuit theory; and feedback and control theory. For applications see: 09 Electronic Equipment. For related information see: Specific Physics Categories. **1426**

11 FACILITIES, RESEARCH AND SUPPORT

Includes airports; lunar and planetary bases including associated vehicles; ground support systems; related logistics; simulators; test facilities (e.g., rocket engine test stands, shock tubes, and wind tunnels); test ranges; and tracking stations. **1429**

12 FLUID MECHANICS

Includes boundary-layer flow; compressible flow; gas dynamics; hydrodynamics; and turbulence. For related information see also: 01 Aerodynamics; and 33 Thermodynamics and Combustion. **1433**

13 GEOPHYSICS

Includes aeronomy; upper and lower atmosphere studies; oceanography; cartography; and geodesy. For related information see also: 20 Meteorology; 29 Space Radiation; and 30 Space Sciences. **1437**

14 INSTRUMENTATION AND PHOTOGRAPHY

Includes design, installation, and testing of instrumentation systems; gyroscopes; measuring instruments and gages; recorders; transducers; aerial photography; and telescopes and cameras. **1444**

15 MACHINE ELEMENTS AND PROCESSES

Includes bearings, seals, pumps, and other mechanical equipment; lubrication, friction, and wear; manufacturing processes and quality control, reliability; drafting; and materials fabrication, handling, and inspection. **1452**

16 MASERS

Includes applications of masers and lasers. For basic research see: 26 Physics, Solid-State. **1455**

17 MATERIALS, METALLIC

Includes cermets; corrosion; physical and mechanical properties of materials; metallurgy; and applications as structural materials. For basic research see : 06 Chemistry. For related information see also: 18 Materials, Nonmetallic; and 32 Structural Mechanics. **1457**

18 MATERIALS, NONMETALLIC

Includes corrosion; physical and mechanical properties of materials (e.g., plastics); and elastomers, hydraulic fluids, etc. For basic research see: 06 Chemistry. For related information see also: 17 Materials, Metallic; 27 Propellants; and 32 Structural Mechanics. **1464**

19 MATHEMATICS

Includes calculation methods and theory; and numerical analysis. For applications see: 08 Computers. **1466**

20 METEOROLOGY
Includes climatology; weather forecasting; and visibility studies. For related information see also: 13 Geophysics; and 30 Space Sciences. 1471

21 NAVIGATION
Includes guidance; autopilots; star and planet tracking; inertial platforms; and air traffic control. For related information see also: 07 Communications. 1474

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Includes nuclear reactors and nuclear heat sources used for propulsion and auxiliary power. For basic research see: 24 Physics, Atomic, Molecular, and Nuclear. For related information see also: 03 Auxiliary Systems; and 28 Propulsion Systems. 1475

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Includes acoustics, cryogenics, mechanics, and optics. For astrophysics see: 30 Space Sciences. For geophysics and related information see also: 13 Geophysics, 20 Meteorology, and 29 Space Radiation. 1482

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Includes atomic, molecular and nuclear physics. For applications see: 22 Nuclear Engineering. For related information see also: 29 Space Radiation. 1487

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26 PHYSICS, SOLID-STATE
Includes semiconductor theory; and superconductivity. For applications see: 16 Masers. For related information see also: 10 Electronics. 1499

27 PROPELLANTS
Includes fuels; igniters; and oxidizers. For basic research see: 06 Chemistry; and 33 Thermodynamics and Combustion. For related information see also: 28 Propulsion Systems. 1504

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Includes air breathing, electric, liquid, solid, and magnetohydrodynamic propulsion. For nuclear propulsion see: 22 Nuclear Engineering. For basic research see: 23 Physics, General; and 33 Thermodynamics and Combustion. For applications see: 31 Space Vehicles. For related information see also: 27 Propellants. 1505

29 SPACE RADIATION
Includes cosmic radiation; solar flares; solar radiation; and Van Allen radiation belts. For related information see also: 13 Geophysics; and 24 Physics, Atomic, Molecular, and Nuclear. 1506

30 SPACE SCIENCES
Includes astronomy and astrophysics; cosmology; lunar and planetary flight and exploration; and theoretical analysis of orbit and trajectory. For related information see also: 11 Facilities, Research and Support; and 31 Space Vehicles. 1507

31 SPACE VEHICLES

Includes launch vehicles; manned space capsules; clustered and multistage rockets; satellites; sounding rockets and probes; and operating problems. For basic research see: 30 Space Sciences. For related information see also: 28 Propulsion Systems; and 32 Structural Mechanics. **1514**

32 STRUCTURAL MECHANICS

Includes structural element design and weight analysis; fatigue; thermal stress; impact phenomena; vibration; flutter; inflatable structures; and structural tests. For related information see also: 17 Materials, Metallic; and 18 Materials, Nonmetallic. **1517**

33 THERMODYNAMICS AND COMBUSTION

Includes ablation, cooling, heating, heat transfer, thermal balance, and other thermal effects; and combustion theory. For related information see also: 12 Fluid Mechanics; and 27 Propellants. **1540**

34 GENERAL

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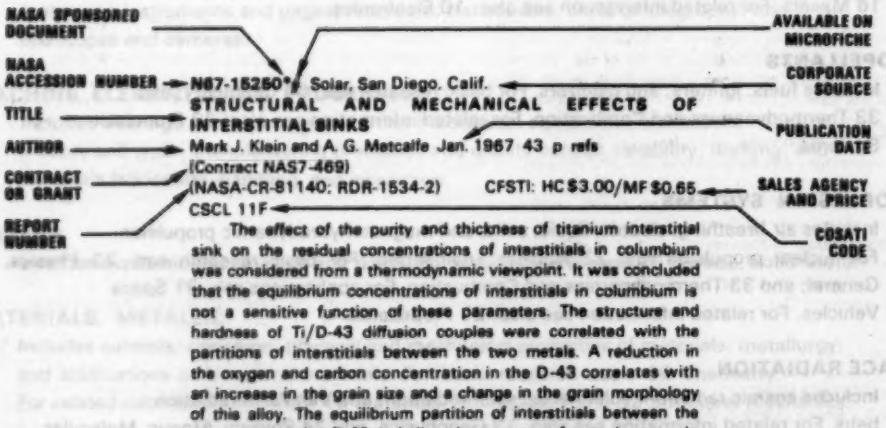
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N67-15250* # Solar, San Diego, Calif.
STRUCTURAL AND MECHANICAL EFFECTS OF INTERSTITIAL SINKS
Mark J. Klein and A. G. Metcalfe Jan. 1967 43 p refs
(Contract NAS7-469)
(NASA-CR-81140; RDR-1534-2)
CFSTI: HC $3.00/MF $0.65
CSCL 11F
The effect of the purity and thickness of titanium interstitial sink on the residual concentrations of interstitials in columbium was considered from a thermodynamic viewpoint. It was concluded that the equilibrium concentrations of interstitials in columbium is not a sensitive function of these parameters. The structure and hardness of Ti/D-43 diffusion couples were correlated with the partitions of interstitials between the two metals. A reduction in the oxygen and carbon concentration in the D-43 correlates with an increase in the grain size and a change in the grain morphology of this alloy. The equilibrium partition of interstitials between the titanium and the D-43 is believed to account for an increase in the hardness of the titanium but this partition does not seem to affect the hardness of the D-43. Author

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01 AERODYNAMICS

Includes aerodynamics of bodies, combinations, internal flow in ducts and turbo machinery; wings, rotors, and control surfaces. For applications see: 02 Aircraft and 31 Space Vehicles. For related information see also: 12 Fluid Mechanics; and 33 Thermodynamics and Combustion.

N67-19408# Toronto Univ. (Ontario).
AERODYNAMIC NOISE
In its Ann. Progr. Rept., 1966 Oct. 1966 p 43–48 (See N67-19403 09-34)

Aerodynamic noise studies revealed a definitive connection between jet turbulence and jet noise based on use of the Proudman form of Lighthill's integral for aerodynamic noise. Work on refraction of sound by gas jets gave rise to a simple model of the directional pattern of jet noise. Briefly, the directivity is dominated by the competing effects of convection and refraction. The effects of refraction and convection can be corrected out of measured jet noise patterns to yield the basic directivity of the eddy noise generators. An analytical computer-oriented study was conducted on the refraction of sound by jet flow and jet temperature. Other areas studied were pressured fluctuations on a plate with oblique jet impingement, distortion of a shock wave traversed by a vortex, and acoustic energy flux from shock-turbulence interaction. S.P.

N67-19409# Toronto Univ. (Ontario).
SUBSONIC AERODYNAMICS
In its Ann. Progr. Rept., 1966 Oct. 1966 p 49–55 (See N67-19403 09-34)

Aerodynamic studies of the flow field of a wing with a peripheral jet near the ground were conducted. A reasonably accurate method of predicting the response of a cylindrical structure to a turbulent flow field at subcritical Reynolds numbers is described. In addition, experiments were conducted with circular cylinders to determine the variation of the vortex shedding frequency with inclination to the stream. Strouhal numbers for cylinders inclined to the wind at Reynolds numbers of 10^4 are discussed. Other studies were devoted to aerodynamic pressures and forces on bodies exposed to a turbulent stream and consideration of air loads on wings in turbulent flow. Investigations were conducted to determine if improvements in the augmentation capabilities of an air ejector could be achieved by re-configuring the primary nozzle cross-section. The following areas were also examined: a rotating hot wire probe for use in subsonic flows, design of a boundary layer wind tunnel, effect of ground-board boundary layer on air cushion vehicle wind tunnel tests, and a computer study of a wing in a slipstream. S.P.

N67-19410# Toronto Univ. (Ontario).
AEROSPACE FLIGHT DYNAMICS
In its Ann. Progr. Rept., 1966 Oct. 1966 p 56–61 (See N67-19403 09-34)

Problems in flight dynamics concerning aircraft, human pilots, hypersonic atmospheric flight, and satellites are considered. During computer studies of hypersonic flight a logic for control of manned entry vehicles was devised which produces what is termed as "isothermal footprints"—i.e., for given initial conditions all points within the maneuver footprint can be reached with the same maximum vehicle temperature. The minor circle flight of a hypersonic vehicle is also investigated. The optimized performance of an articulated gravity gradient satellite at synchronous altitude was determined, and a program on dynamics of human pilots was obtained by augmenting the original simulator with a general purpose analog computer. In addition, the lateral instability of an aircraft due to aerodynamic cross-coupling was investigated. S.P.

N67-19493 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
PROCESSING THE RESULTS OF TRAVERSING TURBINES ON A DIGITAL COMPUTER
A. P. Tunakov *In its* Aviation Eng., Vol. 7, No. 3 28 Sep. 1966 p 95–103 refs (See N67-19481 09-34) CFSTI: HC $3.00

Data processing measurements of traversing flow in turbines is discussed, and a program is described that is applicable to any turbine cascades in static and real conditions. Integrals calculated by the program are those of consumption, adiabatic work during gas expansion, actual and theoretical kinetic energy, and moments in projection to the front and to the axis of the cascade. Following an integration procedure, averaged values are determined for the velocity coefficient of the cascade, angle of outlet flow, and stagnated and static pressures. A block diagram of the program is included, as is a pattern for deciphering results of the calculations. M.W.R.

N67-19751# National Physical Lab., Teddington (England). Aerodynamics Div.
THE FLOW ABOUT A FAMILY OF SIMPLE, BLUNT AND SHARP LEADING-EDGED, TWO DIMENSIONAL AEROFOILS AT TRANSONIC AND LOW SUPERSONIC SPEEDS

W. J. Graham 28 Feb. 1966 59 p refs
(NPL-AERO-1189; ARC-27838; AD-642155) CFSTI: HC $3.00/MF $0.65

The flow about the aerofoils is examined with particular attention to the expansive flow, to supersonic speeds, on the blunt leading edges, and to the subsequent compression. The movements of stagnation and sonic points are analysed. The shock structure in the supersonic compression process is explained, with the aid of a characteristics network. The effects of blunting on lift and lift-drag ratio are considered. Author (TAB)

N67-19973# National Gas Turbine Establishment, Pyestock (England).
A DIGITAL COMPUTER PROGRAM FOR THE THROUGH-FLOW FLUID MECHANICS IN AN ARBITRARY TURBOMACHINE USING A MATRIX METHOD
H. Marsh Jul. 1966 52 p refs
(NGTE-R-282)

A detailed description is given of the development of a computer program for analyzing the flow through axial, radial, and mixed-flow turbo-machines. The theory is based on a through-flow analysis, and the equation for the stream function is solved by a matrix method. The theoretical predictions are compared with experiments for a low speed axial flow compressor, and it is shown that the theory gives a good estimate for the axial velocity profile. Author

N67-19976# Royal Aircraft Establishment, Farnborough (England).
IMPROVED CALCULATIONS OF LEADING-EDGE SEPARATION FROM SLENDER DELTA WINGS
J. H. B. Smith Mar. 1966 123 p refs
(RAE-TR-66070)

The vortex-sheet model of the primary vortices formed by the separation of the flow from the leading-edges of a delta wing of small aspect ratio is discussed. For the case of conical flow past a flat-plate wing, an iterative procedure for the calculation of this model by slender-body theory is described. The convergence of the procedure and the validity of the results are demonstrated empirically. Various properties of the calculated flows are discussed in relation to previous solutions and to experimental observations. It is concluded that the model is worthy of wider application. Author

N67-19987* Lockheed Missiles and Space Co., Huntsville, Ala. Research and Engineering Center.
A NON-ISOTHERMAL WALL BOUNDARY LAYER COMPUTER PROGRAM WITH CORNER EFFECTS
D. V. Hale Jan. 1967 132 p refs
(Contract NAS8-20279)
(NASA-CR-62974; LMSC/HREC-A783820; HREC-0279-1) CFSTI: HC $3.00/MF $0.65 CSCL 01A

A boundary layer computer program is presented which is capable of calculating turbulent or laminar boundary layers and heat rates on non-isothermal wall bodies composed of cone frustums and cylinders. The effects of compression and expansion corners are accounted for in the development. This final contract report contains a description of user's guide for the computer program. The analytical developments are presented also, as well as the steps and logic used in compiling these into a working program. Sample case results are discussed. The results confirm the anticipated fact that the isothermal wall and flat plate assumptions lead to erroneous heat rate predictions. The largest errors are incurred in regions behind temperature discontinuities. The net effect of these assumptions on Saturn class vehicles will be that current heat rate predictions on fuel and oxygen tanks will be low while those on interstage regions will be high. The techniques developed will enable more precise heat rate predictions in the future. Author

N67-20262*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
DISCONTINUOUS FLOWS AND FREE STREAMLINE SOLUTIONS FOR AXISYMMETRIC BODIES AT ZERO AND SMALL ANGLES OF ATTACK
Heinz G. Struck *In its* Aero-Astrodyn. Res. Rev. No. 5 15 Oct. 1966 p 2–12 refs (See N67-20261 09-34)

Except for a few numerical results, nothing has been published comparable in magnitude to the two-dimensional case concerning free streamline solutions of the axisymmetric problem. Since the method of using conformal transformations is not available in axisymmetric and three-dimensional flows, it is necessary to adapt approximate methods for the free streamline analysis. In this study an integral equation procedure has been applied to calculate the free streamline flow behind axisymmetric bodies at zero and small angles of attack. The method uses a modified condition for irrotational flow and iterates until the proper streamline location is found. Some of the results obtained by this procedure will be given and discussed in this report. Author

N67-20263*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
ACOUSTIC AND HEAT TRANSFER ASPECTS OF LAUNCH VEHICLE TURBULENCE
F. Krause and W. K. Dahm *In its* Aero-Astrodyn. Res. Rev. No. 5 15 Oct. 1966 p 14–23 (See N67-20261 09-34)

The regions of intense turbulence that have been identified from schlieren and shadowgraph pictures such as shock waves behind expansion corners and compression corners are reviewed. The pressure fluctuations below the different flow fields are discussed with respect to broad-band and narrow-band excitation of single modes. Heat conduction in recirculation areas at the vehicle base and the associated turbulent heat transfer is also considered. A.G.O.

N67-20302 Aeronautical Research Council (Gt. Brit.)
STUDIES OF SLOTTED-WALL INTERFERENCE USING AN ELECTRICAL ANALOGUE
K. R. Rushton London, HMSO, Jun. 1965 32 p refs Supersedes ARC-26680; see X67-10008 and ARC-27140; see X66-11954
(ARC-R&M-3452; ARC-26680; ARC-27140) CFSTI: $3.00

A study of the lift interference effect in slotted wall wind tunnels performed by a pure resistance electrical analog is described. Both steady and oscillatory flow are considered. Special techniques devised to represent the singular behavior of a point wing and at the edges of each slot are discussed in detail. Comparisions are made with an exact solution based on an equivalent homogeneous boundary condition for steady flow. For oscillatory flow experimental results are presented which show how the magnitude of the interference upwash changes with the frequency of the oscillation. The electrical analogue computer is used to obtain results for two particular steady flow problems. The first involves a comparision between actual slotted walls and an equivalent homogeneous condition. In the second the lift interference for tunnels with all four walls slotted is examined. Author

N67-20303# Aeronautical Research Council (Gt. Brit.)
THE UNSTEADY FORCES ON FINITE WINGS IN TRANSIENT MOTION
B. D. Dore London, HMSO, Sep. 1964 51 p refs Supersedes ARC-26116; NPL-AERO-1113; see X65-18285 and ARC-26195; NPL-AERO-1115; see X65-15476
(ARC-R&M-3456; ARC-26116; ARC-26195; NPL-AERO-1113; NPL-AERO-1115) CFSTI: HC $3.00/MF $0.65

The forces and moments on finite wings undergoing a sudden change of incidence are considered at the start of the unsteady

motion. Linearized theory is used and the flow is assumed to be incompressible. The method presented is suitable for many planforms and applications are made to rectangular and delta wings to yield spanwise and chordwise load distribution. Transient lift and moment functions are considered for sudden plunging motion and for entry into a sharp-edged gust. For sudden plunging motion the functions are calculated from the lift and moment coefficients associated with wings in oscillatory plunging motion. Growth of lift functions due to gust entry are calculated by using a reverse flow theorem and an approximate relationship for the transient chordwise load distribution due to sudden plunging motion; the exact solution for delta wings is derived for the limiting case of infinite aspect ratio. Author

N67-20305# Aeronautical Research Council (Gt. Brit.)
PROCEDURE FOR THE DETERMINATION OF CASCADE CHARACTERISTICS
J. A. P. Stoddart and D. Gardner London, HMSO, Nov. 1964 27 p refs Supersedes ARC-27181; AE-204
(ARC-CP-870; ARC-27181) CFSTI: HC $3.00/MF $0.65

This note presents an approximate procedure for the theoretical calculation of the aerodynamic characteristics of an infinite cascade of arbitrary aerofoils. The effects of subcritical compressibility and viscosity are included and some experimental comparisons are presented. The procedure has been programmed in Alphacode for use on DEUCE. Author

N67-20308# Aeronautical Research Council (Gt. Brit.)
A SURVEY OF UNSTEADY HYPERSONIC FLOW PROBLEMS
B. M. Wood London, HMSO, Mar. 1965 154 p refs Supercedes ARC-26757; NPL-AERO-19
(ARC-CP-901; ARC-26757; NPL-AERO-19) CFSTI: HC $3.00/MF $0.65

After giving general information on hypersonic flows, flight conditions and vehicles, the report reviews work on the analysis of unsteady hypersonic flows, analytical studies of the dynamic stability of hypersonic vehicles, and experimental and analytical work on flutter at hypersonic speeds. On this basis it then examines the need for research and suggests lines that research should follow. The chief conclusion is that the quasi-steady analysis of unsteady hypersonic flows may be adequate for the practical purposes of dynamic stability and flutter analysis. It is suggested that research should be directed to finding the degree of inaccuracy involved in quasi-steady estimates of the unsteady aerodynamic forces, and the sensitivity of dynamic stability and flutter analyses to inaccuracies in these forces. Author

N67-20314# Royal Aircraft Establishment, Farnborough (England).
THRUST AND DRAG WITH HEAT ADDITION TO A SUPERSONIC FLOW [SCHUB UND WIDERSTAND BEI WAERMEZUFUHR IN UEBERSCHALLSTROEMUNG]
Klaus Oswatitsch Jan. 1967 17 p Transl. into ENGLISH from German Presented at the 3rd Euromech Symp., Aachen, West Ger., Feb. 1966 Submitted for publication
(RAE-LIB-TRANS-1161) CFSTI: HC $3.00/MF $0.65

The theoretical background for the generation of thrust forces on bodies in supersonic flow by means of heat addition is discussed. Considered are special features of hypersonic flow, the thrust equations, and heat addition in fronts. Several examples are treated in detail, and hypersonic approximations are explained. K.W.

N67-20321# Aeronautical Research Council (Gt. Brit.)
APPROXIMATE FORMULAE FOR THE LIFT AND DRAG OF WEDGE AEROFOIL SECTIONS AT HIGH SUPERSONIC SPEEDS
L. C. Squire (Cambridge Univ.) London, Min. of Aviation, 1966 16 p refs
(ARC-CP-864; ARC-26748) CFSTI: HC $3.00/MF $0.65

In this paper a correlation is used to obtain approximate formulae for the aerodynamic derivatives of simple wedge airfoils for a wide range of Mach number and incidence. The correlation allows equilibrium real gas effects to be approximated. Author

N67-20322# Aeronautical Research Council (Gt. Brit.)
MEASUREMENTS OF THE DIRECT PITCHING-MOMENT DERIVATIVES FOR FOUR WING PLANFORMS AT TRANSONIC SPEEDS
J. B. Bratt, W. G. Raymer, and J. E. G. Townsend London, Min. of Aviation, 1966 18 p refs Supersedes ARC-15206; ARC-15486
(R&M-3435; ARC-15206; ARC-15486) CFSTI: HC $3.00/MF $0.65

Measurements of the direct pitching-moment derivatives m_q and $m_{\dot{\alpha}}$ at transonic speeds for two delta and two swept wing planforms are discussed. The tests were made in the high speed wind tunnel using slotted liners, a Mach number range from M=0.695 to M=1.07 being attained. These measurements extend earlier subsonic results obtained with solid tunnel liners into the transonic range. Comparison with theory is made for one of the delta wings and the effect of a body on the other was examined. Author

N67-20367# Massachusetts Inst. of Tech., Cambridge. Aerophysics Lab.
SOME PRELIMINARY MEASUREMENTS BEHIND CONES MAGNETICALLY SUSPENDED IN A MACH NUMBER 4.3 STREAM
F. K. Browand, M. Finston, and D. K. McLaughlin Oct. 1966 40 p refs
(Contract AF 49(638)-1328)
(AFOSR-66-2510; TR-132; AD-644824) CFSTI: HC $3.00/MF $0.65

Preliminary results of pitot pressure measurements behind 7 degree half angle cones magnetically suspended in a Mach number 4.3 stream are presented. The cones are at recovery temperature. Pitot pressure data is presented for three Reynolds numbers, and an accurate map of the near wake is obtained. In particular the bounds of the recirculation region, the rapid corner expansion, and the lip shock locations are clearly evident. The length of the recirculation region (about 3 base diameters) is consistent with schlieren observations of the suspended model, and also with ballistic range photographs for similar test conditions. At the lowest Reynolds number the wake bifurcates. This cause is not understood at present. Author (TAB)

N67-20372# Cambridge Univ. (England). Engineering Lab.
THE CALCULATION OF THREE-DIMENSIONAL TURBULENT BOUNDARY LAYERS. 2: ATTACHMENT-LINE FLOW ON AN INFINITE SWEPT WING
N. A. Cumpsty and M. R. Head London, Aeron. Res. Council, 25 Jul. 1966 33 p refs
(ARC-28180; FM-3730) CFSTI: HC $3.00/MF $0.65

A previously published method made use of an entrainment equation and momentum integral equations in streamwise and cross-flow directions, together with several auxiliary assumptions. Here the method is adapted to the calculation of the turbulent boundary layer flow along the attachment line of an infinite swept wing. In this case the cross-flow momentum integral equation reduces to the identity 0=0 and must be replaced by its differentiated form. Two alternative approaches are also adopted and give very similar results, in good agreement with the limited

experimental data available. It is found that results can be expressed as functions of a single parameter, which is evidently the criterion of similarity for attachment-line flows. Author

02 AIRCRAFT

Includes fixed-wing airplanes, helicopters, gliders, balloons, ornithopters, etc; and specific types of complete aircraft (e.g., ground effect machines, STOL, and VTOL); flight tests; operating problems (e.g., sonic boom); safety and safety devices; economics; and stability and control. For basic research see: 01 Aerodynamics. For related information see also: 31 Space Vehicles; and 32 Structural Mechanics.

N67-19422# Aeronautical Research Council (Gt. Brit.)
LOW-SPEED WIND-TUNNEL TESTS ON A DELTA-WING AIRCRAFT MODEL (S.R.177) WITH BLOWING OVER THE TRAILING-EDGE FLAPS AND AILERONS.
S. F. J. Butler and M. B. Guyett London, HMSO, 1966 99 p refs Supersedes RAE-AERO-2671; ARC-24502
(ARC-CP-710; RAE-AERO-2671; ARC-24502) CFSTI: HC $3.00/MF $0.65

Low speed longitudinal stability measurements are described on a delta-wing aircraft model of aspect-ratio 2.9 and 40° leading-edge sweepback, with shroud blowing over trailing-edge flaps and ailerons. With blowing over the flap alone at a flap angle of 60° (aileron undeflected), increases were obtained of 0.27 in trimmed C_L at constant incidence and of 0.18 in trimmed $C_{L_{max}}$ at the value of C_μ (0.031) envisaged for the projected aircraft. By distributing the same total jet momentum to flap and aileron, with 30° aileron mean droop, further lift increases were obtained corresponding to additional reductions of about 8 knots in aircraft speeds. The beneficial effect of the L. E. flap was large, amounting to 5° increase of stalling angle and 0.3 increase in $C_{L_{max}}$ with blowing over trailing-edge flaps and ailerons. The measured effects of blowing correlated well with results of other model tests involving similar wing-flap arrangments. In particular, part-span blown flaps were again found to produce large drag increments significantly affecting the aircraft minimum drag speed. Author

N67-19498 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
A MORE PRECISE DEFINITION OF THE CONCEPT "TECHNOLOGICAL CHARACTER OF DESIGNS"
I. T. Belyakov *In its* Aviation Eng., Vol. 7, No. 3 28 Sep. 1966 p 137–141 refs (See N67-19481.09-34) CFSTI: HC $3.00

Structural variants and parameters for the development of gliders and other aircraft are described by citing examples of alternate airframes and cast components. Attention is given to the so-called "technological character of design," which includes factors such as geometric form, accuracy of dimensions, purity of surface treatment, specific gravity of elements, and dismemberment of design into components and assembly units. This concept does not extend to the operation of the aircraft, however. Effectiveness of new machine design is discussed in terms of the national economy and expenditures. M.W.R.

N67-19665# Frankford Arsenal, Philadelphia, Pa. Ammunition Development and Engineering Labs.
PRE-MISSION PREPARATION OF FLARE, AIRCRAFT, PARACHUTE, MK 24, ALL MODS WITH SAFETY LANYARD RETROFIT
A. J. Grandy Sep. 1966 28 p refs
(TN-1116; AD-640812) CFSTI: HC $3.00/MF $0.65

A field method is described for retrofitting existing MK 24 flares with a 50-foot safety lanyard in order to increase fuze arming distance when these flares are manually launched from the interior of fixed or rotary wing aircraft. Author (TAB)

N67-20359# Lockheed-Georgia Co., Marietta.
PLAN FOR THE DEVELOPMENT OF ALL WEATHER LANDING SYSTEM RELIABILITY ANALYSIS AND CRITERIA, PHASE I
L. A. Adkins, L. D. Schiller and M. C. Thatro Jan. 1966 117 p refs
(Contract FA-65WA-1376)
(RD-66-2; ER-8316; AD-644417) CFSTI: HC $3.00/MF $0.65

The report outlines the basic plan and approach which will be used for generation of an AWLS assessment criteria and evaluation methodology. The criteria and methodology to be formulated will be for application on the category III AWLS ground-based system, which will be phase II of the study program, and for the airborne portions of the system, which will be treated in phase III of the program. Of particular significance is the consideration of safety, reliability, and total performance evaluation. The phase I report presents a complete bibliography on AWLS technology. In addition, treatment is presented on the applications of reliability, human factors, safety, quantification, and total performance for the evaluation of all weather landing systems. Author (TAB)

03 AUXILIARY SYSTEMS

Includes fuel cells, energy conversion cells, and solar cells; auxiliary gas turbines; hydraulic, pneumatic and electrical systems; actuators; and inverters. For related information see also: 09 Electronic Equipment; 22 Nuclear Engineering; and 28 Propulsion Systems.

N67-19451# Pratt and Whitney Aircraft, East Hartford, Conn.
FIVE HUNDRED WATT FUEL CELL POWERPLANT Final Report, 1 Oct. 1964–15 Jun. 1966
T. G. Schiller Oct. 1966 74 p
(Contract DA-28-043-AMC-00320(E))
(PWA-2905; ECOM-00320-F; Rept.-2; AD-640700) CFSTI: HC $3.00/MF $0.65

The feasibility of a man-portable, 500 watt, indirect liquid hydrocarbon and air, fuel cell powerplant was established. Two independent units were developed - a Hydrogen Generator Assembly and a Fuel Cell Assembly. The Hydrogen Generator Assembly converts the hydrocarbon fuel to hydrogen by steam reforming, and the Fuel Cell Assembly electrochemically oxidizes the hydrogen with air to produce electrical energy. The two units are integrated for operation and designed to produce 500 watts of net electrical power. Author (TAB)

N67-19528# Yardney Electric Corp., New York.
DEVELOPMENT OF THE HIGH RATE METAL-AIR DEPOLARIZED BATTERIES Quarterly Report, 1 Apr.–30 Jun. 1966

J. Goodkin Oct. 1966 31 p
(Contract DA-28-043-AMC-01614(E))
(ECOM-01614-4; Rept.-4; QR-4; AD-644366) CFSTI: HC $3.00/MF $0.65

The report covers work conducted to determine performance characteristics and operational parameters for various metal-air couples. The anode materials that were examined are Al, Ba, Ca, Mg, and Zn. They should discharge efficiently from -25F to +125F, based on a 30 minute rate to a 50 hour rate. The most efficient system is the Zn-Air system. 16 AH batteries gave utilizations of from 88 to 74 WH/lb, depending on c.d. This decrease in energy density is due to a slight decrease in coulombic efficiency and also to a voltage polarization. Low rate discharges of the 16 AH cell show that large air ports result in severe decreases in capacity at high temperatures. At the 50 hour rate, cells with 200 mil ports yielded 50 hours of discharge at -25F, but only 16 hours at 125F. The use of air restriction plates increased the high temperature discharge time to 30 hours. Severe limitation of air flow for high temperature-low rate operation is indicated. Author (TAB)

N67-19722# Air Force Systems Command, Kirtland AFB, N. Mex. Air Force Weapons Lab.
FLUID-STATE FUZING SYSTEM Technical Report, May-Jul. 1966
James E. Bickel and William R. Cowherd Nov. 1966 35 p
(AFWL-TR-66-100; AD-642098) CFSTI: HC $3.00/MF $0.65

The study determined the temperature and mass flow-rate variation of a gas out of a system which included a cold-gas storage bottle, a pressure regulator, and a flow restrictor. These analyses were based on a polytropic expansion in the storage bottle, a throttling process across the pressure regulator in which the departure from an ideal gas was taken into account, and the choke-flow relationship for determining the mass flow out of the system. The variation in the compressibility factor for a real gas was included in these analyses. Results presented are for gaseous nitrogen. Various tank volumes, coefficients of expansion, and both constant and variable flow rates were considered. The variable flow-rate case assumed no heat transfer between the gas and the plumbing which separates the pressure regulator and flow restrictor, i.e., the stagnation gas temperature upstream of the flow restrictor was the same as gas temperature just downstream of the pressure regulator. From these results it is concluded that for the storage bottle volumes and mass flow rates considered, a significant variation in the gas temperature and mass flow rate out of the system is experienced. To determine the feasibility of utilizing a cold-gas storage bottle supply in any system design, the effect of these variations on the system performance must be considered. Author (TAB)

N67-19759# Battery Corp. of America, Fort Lauderdale, Fla.
NEW MAGNESIUM ANODE STRUCTURE Semiannual Report, 1 Mar.-31 Aug. 1966
Rodolfo Rodriquez Balaguer Nov. 1966 55 p
(Contract DA-28-043-AMC-01998(E))
(SAR-1; Rept.-6; ECOM-01998-1; AD-643545) CFSTI: HC $3.00/MF $0.65

The basic D cell made on this contract has the same construction as that developed on previous contracts except for an improved carbon cup which utilizes a thermosetting resin binder instead of the coal tar pitch formerly used. Eleven experimental lots have been made and put on test to evaluate various materials for the cell jacket, the anode sealing washer and the insulating and reinforcing tape. At this time, no definite differences in performance have been observed between cells using different materials of construction. Capacity maintenance at 130F has been over 90 percent at up to three months. Uniformity has been good. The feasibility of making a C cell has been demonstrated and work is under way on equipment to make this size cell using the same design and materials of construction as are used in the D cell. Author (TAB)

N67-19841# Arizona Univ., Tucson. Engineering Experiment Station.
THE EFFECT OF SIMULATED FISSION PRODUCTS IN THE INTER-ELECTRODE SPACING OF A THERMIONIC DIODE Annual Report, 1 Nov. 1965-31 Oct. 1966
Monte V. Davis, E. J. Britt, and D. M. Turner 17 Dec. 1966 21 p refs
(Contract Nonr-2173(13))
(AR-2; AD-644650) CFSTI: HC $3.00/MF $0.65

The effect of iodine impurities on the tantalum emitter of a diode are shown photographically. The development of the Mark III and IV systems are shown, and the preliminary experiments on the vapor deposited tungsten surfaces are discussed. Author (TAB)

N67-19884*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
EXPERIMENTAL SIMULATION OF A REACTION JET DAMPING AND ATTITUDE CONTROL SYSTEM FOR A SPINNING BODY
John G. Shearin and Carolyn Grantham Washington, NASA, Mar. 1967 20 p refs
(NASA-TN-D-3843) CFSTI: HC $3.00/MF $0.65 CSCL 13G

An experimental simulation of an on-off reaction jet damping and attitude control system for spinning bodies has been conducted. The control system derives torques from the thrust generated by four pneumatic jets equally spaced on the periphery of the simulator. Command signals have exceeded a preselected dead band. This system then provides the necessary torques for damping the wobbling motion when a mass shift occurs and the capability to control body attitude for bodies having the inertia distribution of a flat disk or rod shaped configuration. Author

N67-19894* AiResearch Mfg. Co., Phoenix, Ariz.
DESIGN AND FABRICATION OF A HIGH-PERFORMANCE BRAYTON CYCLE RADIAL-FLOW GAS GENERATOR
Washington, NASA, Feb. 1967 134 p
(Contract NAS3-2778)
(NASA-CR-706; APS-5200-R) CFSTI: $3.00 CSCL 10B

A program is described which consisted of analyses, design, gas bearing development and fabrication of a radial-flow gas generator (turbocompressor) for performance evaluation by NASA. The respective turbine and compressor components, identical to those in the gas generator, were delivered in separate research packages utilizing oil-lubricated ball bearings for detail aerodynamic performance investigations. A gas generator was delivered that operated satisfactorily on its gas journal and thrust bearings at 38,500 rpm design speed at 500°F turbine inlet temperature. Author

N67-19912* Globe-Union, Inc., Milwaukee, Wis.
A PROGRAM TO DEVELOP A HIGH-ENERGY DENSITY PRIMARY BATTERY WITH A MINIMUM OF 200 WATT HOURS PER POUND OF TOTAL BATTERY WEIGHT Quarterly Report, 1 Oct.-31 Dec. 1966
William E. Elliott, Robert W. Adler, James R. Huff, Judith L. Gower, and Warren L. Towle 15 Jan. 1967 72 p
(Contract NAS3-8015)
(NASA-CR-72189; QR-10) CFSTI: $3.00 CSCL 10C

Film formation has been demonstrated to occur on cupric fluoride electrodes discharged in organic electrolytes. In addition, pretreatments of the solute, solvent, electrolyte, and cathodes to remove moisture did not significantly improve performance. Even the addition of the dispersive Maracel"E", although it increased coulombic yields from 10% to values in the range 13–24%, did not yield good performance. The water content of N-nitrosodimethylamine has been reduced to 70 ppm by pretreatment with P_2O_5 and vacuum distillation. X-ray diffraction has been used to identify solid compounds and solid cathode discharge products such as LiF and Cu_2O. The filming problem is not solved and much experimental work remains to be completed before an understanding of film formation and minimization can be completed to achieve good cupric fluoride performance. Author

N67-19918*# Union Carbide Corp., Cleveland, Ohio. Fuel Cell Dept.
DEVELOPMENT OF FUEL CELL ELECTRODES Semiannual Report, 30 Jun. 1966–30 Dec. 1966
M. B. Clark and G. E. Evans 31 Dec. 1966 66 p
(Contract NAS3-9430)
(NASA-CR-72178) CFSTI: HC $3.00/MF $0.65 CSCL 10A

The applicability to aerospace requirements of a fuel cell system employing circulating liquid electrolyte and water removal via transpiration through porous electrodes is being investigated. Most of the effort covered in the present report concerns upgrading of electrode and cell performance. The best (4"×5") cell constructed to date has operated at 200 ASF continuously for 800 hours at atmospheric pressure with a constant terminal voltage of 885±5 mv, with the test still in progress. Author

N67-19920* American Cyanamid Co., Stamford, Conn. Research Labs.
DEVELOPMENT OF HIGH-PERFORMANCE LIGHT-WEIGHT ELECTRODES FOR HYDROGEN–OXYGEN FUEL CELLS Final Report, 5 Apr. 1965–5 Jul. 1966
D. Gershberg, W. P. Colman, and J. Di Palma 1 Mar. 1967 143 p refs
(Contract NAS3-6477)
(NASA-CR-72166) CFSTI: $3.00 CSCL 10A

Efforts were directed toward determining and recommending preferred conditions at 100° to 200°C under which the electrodes would give sustained high performance in a total module having a weight-to-power ratio substantially lower than those presently available for space environment. The program included evaluating potentially suitable matrix materials, initial electrode performance studies, and life testing in small and battery-size cells. The electrodes gave high initial performance at 100° to 200°C and 0 to 60 psig. Available matrices limited the maximum temperature for long-term operation to about 100°C. A Ceria-PTFE matrix extended this limit to at least 125°C. High sustained performance was achieved for 1200 to 5800 hrs. in 26 cm^2 active area cells operating at 100° to 120°C and atmospheric pressure. Stable operation was shown at 150°C for 400 hrs. Operating variables affecting performance stability were caused primarily by matrix deficiencies, insufficient electrolyte, and electrolyte diffusion limitations. Electrodes operated stably at atmospheric pressure and 300 ma/cm^2 for 1000 hrs. Preferred conditions were recommended for operation at 100 to 300 ma/cm^2 with or without provision for cold restart. R.N.A.

N67-20015# Electric Storage Battery Co., Yardley, Pa. Carl F. Norberg Research Center.
HIGH ENERGY SYSTEM (ORGANIC ELECTROLYTE) Quarterly Report, 15 Jun.–15 Sep. 1966
D. P. Boden, H. R. Buhner, and V. J. Spera Dec. 1966 97 p refs
(Contract DA-28-043-AMC-02304(E))
(ECOM-02304-1; QR-1; Rept.-5; AD-643935) CFSTI: HC $3.00/MF $0.65

A screening program was carried out to investigate the electrochemical behaviour of several organic and inorganic cathodes when discharged in non-aqueous electrolytes. The majority of the materials discharged only poorly with the exception of AgO, bis-benzo furoxane sulphone and m-dinitrobenzene. These compounds gave results warranting further study. Statistical analysis of the preparative variables of the silver oxide cathode revealed that optimum performance is achieved with a cathode containing no binder or conducting additive. A Latin Square analysis of the floc method of preparing CuF2 cathodes revealed that the performance was in general lower than the hot pressed types. Promising results were obtained from hot pressed CuF2 electrodes discharged in 2F LiC104/Dimethyl carbonate. When discharged at 7 ma/sq cm the cathodes gave 60% coulombic efficiency compared to 60% utilization at 2 ma/sq cm in 1F LiC104/P.C. Solubility studies of CuF2 in solutions of LiC104 in propylene carbonate have shown that a major cause of the dissolution of CuF2 is the impurities in the LiC104. Author (TAB)

N67-20190# Air Force Systems Command, Wright-Patterson AFB, Ohio. Air Force Aero Propulsion Lab.
OPTIMUM MAGNETS FOR MHD GENERATORS
Robert R. Barthelemy and Charles E. Oberly Jul. 1966 20 p refs Presented at the Intern. Symp. on Magnetohydrodyn. Elec. Power Generation, Saltzburg, Austria, 4–8 Jul. 1966 Submitted for publication
(AFAPL-CONF-67-2; SM-74/167; AD-643832) CFSTI: HC $3.00/MF $0.65

The purpose of this study is to define the areas of applicability for permanent, conventionally cooled resistive, cryogenically cooled resistive, and superconductive magnets to open cycle MHD power generation systems. The selection of magnet types for stationary and mobile systems as well as for short and long duration systems is made. The results of the investigation are presented in summary form for three types of MHD generators. These results are plotted on power duration and net power output coordinates to show the economical operating regimes of the various types of magnets. Both a weight and cost optimum regime are shown for the entire MHD generator operating range. The most significant result of the analysis is that high-purity aluminum magnets cooled with liquid hydrogen exhibit a wide range of application from both a cost and weight standpoint. Author (TAB)

N67-20260* Allis-Chalmers Mfg. Co., Milwaukee, Wis.
DEVELOPMENT OF 2 KW FUEL CELL POWER SYSTEMS
J. R. Hurley 19 Nov. 1964 10 p
(Contract NAS8-2696)
(NASA-CR-83001) CFSTI: HC $3.00 CSCL 10A

The overall electrical aspects of the fuel cell power system are considered, and specifications are listed for the nominal power rating, overload rating, voltage regulation, thermal efficiency, and life requirements. The voltage regulation is identified as the major factor to be considered in determining both the cell design area and the number of sections to be used in series. In developing the system, both short mission and long mission power system requirements are to be considered. The basic building block is to consist of a canister containing a single fuel cell module and the associated support subsystems. Recommendations for improving volt–ampere (V–A) characteristics are proposed. It is concluded that the 720-hour mission requirements can be met with present cell V–A characteristics and centerline design when two canisters are used in parallel. However, achievement of a 2000-watt capability in a single canister will require growth in cell capacity. M.G.J.

N67-20320# Royal Aircraft Establishment, Farnborough (England).
PRELIMINARY ESTIMATES OF THE THERMAL BEHAVIOUR OF A PROPANE JET CONTROL SYSTEM IN THE BLACK ARROW SATELLITE
A. G. Earl Sep. 1966 29 p ref
(RAE-TR-66301) CFSTI: HC $3.00/MF $0.65

A preliminary theoretical investigation is made into the thermal behavior of a propane jet control system in the proposed Black Arrow satellite. The results indicate that acceptable thermal conditions should be obtained, both for the propane system and for other components in the satellite, without the need for active temperature control. The heat available for boiling the propane appears to be generous for anticipated control system demands. Author

N67-20368# British Hydromechanics Research Association, Cranfield (England).
AN ELECTRICAL CONTROL FOR FLUID LOGIC ELEMENTS
A. B. Render (Printing, Packaging and Allied Trades Res. Assoc.) [1967] 6 p Presented at 2d Cranfield Fluids Conf., Cambridge, 3–5 Jan. 1967
(F-1) CFSTI: HC $3.00/MF $0.65

An electrically controlled fluidic element, utilizing the piezoelectric effect, has been devised. This paper describes the construction and performance of the elements. It is concluded that the response of units which have been constructed is adequate for many applications and that the frequency response can be substantially improved with very little development. Author

04 BIOSCIENCES

Includes aerospace medicine, exobiology, radiation effects on biological systems; physiological and psychological factors. For related information see also: 05 Biotechnology.

N67-19419# Oak Ridge National Lab., Tenn.
BIOLOGY DIVISION SEMIANNUAL PROGRESS REPORT, PERIOD ENDING JANUARY 31, 1966
Alexander Hollaender, S. F. Carson, and J. L. Liverman May 1966 207 p refs
(Contract W-7405-ENG-26)
(ORNL-3922) CFSTI: HC $3.00/MF $0.65

Comprehensive data are presented for various biological concepts reported in the fields of genetics, radiation immunology, cytology, biophysics, viral physiology, pathology, and enzymology. Published information lists 435 papers, abstracts, and book reviews for this reporting period. Meetings and conferences mentioned include: Symposium on the Nucleolus, Its Structure and Function; Bone Marrow Conferences; and the Nineteenth Annual Biology Research Conference. Technological reporting also includes work in: fungal genetics, *Drosophila melangaster* cytology, cytochemistry and cell reproduction, mammalian genetics, human cytogenetics, radiation microbiology, subcellular and viral physiology, nucleic acid chemistry, nucleic acid enzymology, plant physiology and photosynthesis, microbiology, and biochemical regulation. Bibliographic information completes each section. AEC–NIH cooperative programs highlight chemical carcinogenesis, and ultracentrifuge development. R.L.I.

N67-19521# California Univ., Berkeley. Lawrence Radiation Lab.
CHEMICAL BIODYNAMICS ANNUAL REPORT, 1966
Mar. 1966 81 p refs Sponsored by AEC
(UCRL-16806) CFSTI: HC $3.00/MF $0.65

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N67-19522# California Univ., Berkeley. Lawrence Radiation Lab.
APPLICATIONS FOR ESR, MOESSBAUER, ELECTRONIC, AND OPTICAL ROTATORY SPECTRA TO PROBLEMS IN BIOLOGY
Melvin P. Klein *In its* Biodyn. Ann. Report, 1965 Mar. 1966 p 6–8 (See N67-19521 09-04) CFSTI: HC $3.00/MF $0.65

The variety of spectroscopic techniques being applied to the study of intact biological systems, to component parts of such systems, to individual molecules, and to model systems is discussed.

The objective of these investigations is to relate structural parameters and details to biological functions. Consideration is given to studies on electron spin resonance signals that occur when photosynthetic materials are illuminated by light, ESR signals of *Rhodospirillum rubrum* at liquid helium temperatures, complexes between porphyrins and metal ions in biological materials, and the Mossbauer spectra of iron-containing materials. Also discussed are the electron spectroscopic method for determining atomic energy levels, electron spectrum studies of sulfur in a number of proteins, and optical rotatory dispersion research. A.G.O.

N67-19523# California Univ., Berkeley. Lawrence Radiation Lab.
THE EFFECTS OF DAY LENGTH OF QUANTASOME STRUCTURE AND CHLOROPLAST PHOTOCHEMISTRY IN *SPINACIA OLERACEA* L. VAR. EARLY HYBRID #7
Roderic B. Park and Susan Drury *In its* Chem. Biodyn. Ann. Report, 1965 Mar. 1966 p 9–14 refs (See N67-19521 09-04)
CFSTI: HC $3.00/MF $0.65

The effects of photoperiod on the efficiency and internal structure of chloroplast membranes are investigated. Preliminary results show that chloroplasts isolated from 4- to 5-week-old short-day spinach plants are 20 to 100% more efficient than long-day chloroplasts as assayed by Hill reaction activity. This difference in efficiency is correlated with differences in the internal membrane system of the chloroplast as seen both in thin section and in shadowed material. The chlorophyll/N ratio of both long- and short-day membranes is the same, which to a first approximation indicates that the difference in efficiency between the two membranes may be largely a difference in structure rather than a difference in chemical composition. A.G.O.

N67-19524# California Univ., Berkeley. Lawrence Radiation Lab.
PHOTOSYNTHESIS OF CARBON COMPOUNDS
J. A. Bassham, Martha Kirk, T. A. Pedersen, Richard Jensen, C. N. Hetzer et al *In its* Chem. Biodyn. Ann. Report, 1965 Mar. 1966 p 25–30 refs (See N67-19521 09-04) CFSTI: HC $3.00/MF $0.65

The photosynthetic pathways by which carbon dioxide, phosphate, and other inorganic compounds are converted to organic compounds are being investigated. Emphasis is being placed on studies of the mechanisms of the transfer of electrons and phosphate groups to the carbon compounds, and the effects of light quality on the products of photosynthesis and glycolysis in the photosynthetic apparatus in vivo and in isolated chloroplasts. Light-dark transient changes in labeling of compounds in the photosynthetic carbon reduction cycle and related compounds were determined, and the possible significance of these changes is discussed. Considerable effort has been spent developing chloroplast isolation and incubation methods to give good CO_2 fixation rates, and it is reported that studies with isolated spinach chloroplasts have produced rates of CO_2 fixation as high as 20% of normal in vivo rates. A.G.O.

N67-19525# California Univ., Berkeley. Lawrence Radiation Lab.
PRODUCTION OF CYSTEIC ACID, TAURINE, AND CYSTAMINE UNDER PRIMITIVE EARTH CONDITIONS
Ahmed S. U. Choughuley and Richard M. Lemmon *In its* Chem. Biodyn. Ann. Report, 1965 Mar. 1966 p 42–43 refs (See N67-19251 09-04) CFSTI: HC $3.00/MF $0.65

Experiments were performed in an attempt to demonstrate the "primitive-earth" synthesis of sulfur-containing amino acids. To increase the detection sensitivity for an amino acid product, $H_2{}^{35}S$ was used as one of the reactants. By this method the appearance of cysteic acid, and the closely related compounds, taurine and cystamine, was established. It is also noted that cysteine and cystine probably were formed, but they appeared to be oxidized to cysteic acid during chromatographic analyses. A.G.O.

N67-19534# Library of Congress, Washington, D. C. Aerospace Technology Div.
AUTONOMIC AND CARDIOVASCULAR DISORDERS DURING CHRONIC EXPOSURE TO SUPER-HIGH FREQUENCY ELECTROMAGNETIC FIELDS Surveys of Foreign Scientific and Technical Literature
Sheila Penners 6 Oct. 1966 8 p refs Transl. into ENGLISH from Gigiena Truda i Prof. Zabolevaniya (Moscow), v. 10, no. 7, 1966 p 13–17
(ATD-66-124; AD-644360) CFSTI: HC $3.00/MF $0.65

The clinical observation of persons chronically exposed to intense SHF radiation indicates that in individual cases the angiodystonic manifestations caused by chronic exposure to SHF radiation may develop further into more serious autonomic and cardiovascular pathologies. These are characterized by a tendency to antiospastic reactions and cerebral autonomic vascular attacks accompanied by pronounced arterial pressure lability and coronary spasms with corresponding changes in EKG. Author (TAB)

N67-19556# Texas Nuclear Corp., Austin.
EXPERIMENTAL FAST NEUTRON DOSIMETRY AND LD 50/30 STUDIES IN MICE Final Report, 1 Sep. 1965–31 Aug. 1966
I. L. Morgan, J. B. Ashe, L. D. England, S. C. Mathur, and P. S. Buchanan 31 Aug. 1966 53 p refs
(Contract AF 41(609)-2947)
(AD-639758) CFSTI: HC $3.00/MF $0.65

The report concerns experimental 14 MeV neutron dosimetry using mice as neutron scattering samples and an LD 50/30 study of mice using 14 MeV neutrons and 2 MeV X-rays. The irradiations for the LD 50/30 study were carried out using computed neutron-flux-to-dose values. The experimental neutron dosimetry study is described, not only for mice but for three tissue-equivalent type materials: polyethylene, nylon, and Shonka plastic. TAB

N67-19561 Kansas State Univ., Manhattan. Dept. of Psychology.
THE EVOLUTION OF PERCEPTUAL FRAMES OF REFERENCE
William Bevan and Harry Helson Jul. 1966 72 p refs
(Contract Nonr-3634(01))
(AD-635784) CFSTI: HC $3.00/MF $0.65

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2. AN ADAPTATION-LEVEL INTERPRETATION OF REINFORCEMENT W. Bevan 39 p refs (See N67-19563 09-04)

3. STIMULUS VARIATION AND RECALL: THE ROLE OF BELONGINGNESS W. F. Dukes and W. Bevan 8 p refs (See N67-19564 09-04)

4. OPERANT LEVEL FOLLOWING A QUALITATIVE CHANGE IN LIQUID REINFORCEMENT W. Bevan, R. A. Bell, and H. G. Lankford 7 p refs (See N67-19656 09-04)

N67-19562 Kansas State Univ., Manhattan. Dept. of Psychology.
STIMULUS GENERATION AS A FUNCTION OF A CONTEXTUAL STIMULI

Harry Helson and Lloyd L. Avant *In its* Evolution of Perceptual Frames of Ref. Jul. 1966 9 p refs Submitted for publication (See N67-19561 09-04) CFSTI: HC $3.00/MF $0.65
(TR-41)

In the experiments described, size rather than color was used as the relevant variable in order to provide a more rigorous test of the frame of reference or central tendency hypothesis. Twenty-five male subjects randomly assigned to five groups participated; stimuli were squares cut from black construction paper and mounted in the center of 14 in. square white posterboard sections. The squares ranged by 1/8 in. increments from 2-1/2 to 3-1/2 in. Subjects were shown a square, and then asked to determine if the following series of squares were the same size or different. Results indicate that in each of the asymmetric distributions the largest percent of same responses shifted toward the central stimulus. The point is made that operationally the stimuli used in testing for stimulus generalization affects the generalization gradient as well as the originally learned stimulus.
M.G.J.

N67-19563 Kansas State Univ., Manhattan. Dept. of Psychology.
AN ADAPTATION-LEVEL INTERPRETATION OF REINFORCEMENT
William Bevan *In its* Evolution of Perceptual Frames of Ref. Jul. 1966 39 p refs Submitted for publication (See N67-19561 09-04) CFSTI: HC $3.00/MF $0.65
(TR-42)

Basic theoretical ideas on the phenomena associated with reinforcement are reviewed as background to the adaptation level (AL) interpretation concept. The theory stemmed from consideration of the elation and depression effects following shifts in the magnitude of reinforcers. The approach taken is to view reinforcement as a continuous process, changing as inputs change, but always providing the reference value for defining the effectiveness of a particular reinforcing agent on any given trial and the net effectiveness of a set of reinforcers over a block of trials. In constructing the idiomatic language of the theory, care was taken to include reference to the curvilinear relationship which is held to characterize arousal and performance. Details are given on the basic experiments which were conducted to illustrate the concept of effective stimulus magnitude; reinforcers as psychophysical stimuli; reinforcers as effective stimulus magnitudes; reinforcers and the principle of pooling; and average intensity, performance, and tension levels. Several applications of the theory are given; a bibliography of references is included.
M.G.J.

N67-19564 Kansas State Univ., Manhattan. Dept. of Psychology.
STIMULUS VARIATION AND RECALL: THE ROLE OF BELONGINGNESS
W. F. Dukes (Calif. Univ., Davis) and William Bevan *In its* Evolution of Perceptual Frames of Ref. Jul. 1966 8 p refs Submitted for publication (See N67-19561 09-04) CFSTI: HC $3.00/MF $0.65
(TR-43)

A total of 261 female subjects, tested in groups, were presented brief exposures of noun–adjective pairs. They were then asked to first list the nouns they could remember and later the adjectives. There were two experimental variables: repetition versus variation of particular noun–adjective combinations, and the belongingness versus the non-belongingness of the adjective to the noun. Variation proved superior to repetition as a condition of recall of the nouns regardless of the probability character of the noun–adjective association. Variation was most effective when the pairs were high in belongingness. In contrast, belongingness exerted no influence upon recall of the nouns under the repeated condition. Recall of the adjectives was proportionately better when the noun–adjective combinations were repeated.
Author

N67-19565 Kansas State Univ., Manhattan. Dept. of Psychology.
OPERANT LEVEL FOLLOWING A QUALITATIVE CHANGE IN LIQUID REINFORCEMENT
William Bevan, Russell A. Bell, and H. G. Lankford *In its* Evolution of Perceptual Frames of Ref. Jul. 1966 7 p refs Submitted for publication (See N67-19561 09-04) CFSTI: HC $3.00/MF $0.65
(TR-44)

Experiments were conducted to examine the possibility of producing a qualitative contrast effect using the white rat in a simple performance task, with a change in sensory quality rather than cognitive cue as the reinforcement condition. Interest was also focused on studying the meaning of a change in sensory quality for a change in reinforcer effectiveness. Animals were shaped to press the bar for water, and divided into three groups. The control group was kept on water for the entire experiment; the other two groups were placed on nonnutrient flavored reinforcement. It was concluded that the data supported the two hypotheses being tested: (1) Animals exposed to flavored liquid would display a relatively lower response rate when returned to water than those kept on water throughout. (2) Animals adapted to flavored solutions, different in quality but approximately equivalent in reinforcer effectiveness, would show no difference in their subsequent response to water.
M.G.J.

N67-19574# Library of Congress, Washington, D. C. Aerospace Technology Div.
RESEARCH DATA ON THE STANDARDIZATION OF ELECTROMAGNETIC FIELDS IN THE SHORT AND ULTRA-SHORT WAVE RANGES [MATERIALLY ISSLEDOVANIY K NORMIROVANIYU ELEKTROMAGNITNYKH POLEY DIAPO-ZONA KOROTKIKH i ULTRAKOROTKIKH VOLN]
P. P. Fukalova, M. S. Tolgskaya, S. V. Nikogosyan, I. A. Kitsovskaya, and I. N. Zenina 27 Sep. 1966 13 p refs Transl. into ENGLISH from Gigiena Truda i Prof. Zabolevaniya (Moscow), no. 7, 1966 p 5–9
(ATD-66-126; TT-67-60347; AD-644537) CFSTI: HC $3.00/MF $0.65

The conclusion is drawn that an intensity of 20 v/m in the short-wave range may therefore be recommended as the permissible threshold. An evaluation study of the effectiveness of the protective measures introduced on the authors recommendation for the benefit of workers operating within electromagnetic fields in the communications industries and industries engaged in the heat treatment of dielectrics showed that the adopted measures reduced the effects of radiation to permissible levels and therefore may be recommended as standards for other industries.
Author (TAB)

N67-19674# School of Aerospace Medicine, Brooks AFB, Tex.
AUTO- AND CROSS-CORRELATION OF THE EEG FOLLOWING UNILATERAL CALORIC STIMULATION OF THE LABYRINTH Final Report, Jun. 1964–Feb. 1966
E. Liske, Harry M. Hughes, and Darwell E. Stowe Aug. 1966 14 p refs Submitted for publication
(SAM-TR-66-76; AD-641016) CFSTI: HC $3.00/MF $0.65

Twenty-eight neurologically and medically normal Air Force males between the ages of 18 and 23 years underwent unilateral

caloric stimulation of the labyrinth while the brain waves were monitored by the electroencephalograph. In addition, eye movements were recorded by electro-oculograph, and all bioelectric signals were recorded in FM mode on magnetic tape. The brain waves were then digitized and analyzed on digital computer with an auto- and cross-correlation program. The results of the study show that unilateral caloric stimulation of the labyrinth has no significant effect on the alpha activity generators on either side of the brain. Further, those neuronal circuits responsible for maintaining calorically induced nystagmus do not significantly alter those neuronal circuits which generate alpha activity. Lastly, no phase shift between bilateral alpha activity could be induced by the unilateral caloric stimulation of the labyrinth. Author (TAB)

N67-19682# University Coll. of North Staffordshire, Keele (England). Dept. of Communication.
NEW METHODS OF ANALYSIS OF ELECTROPHYSIOLOGICAL RESPONSES Final Scientific Report
Donald M. Mackay, D. Aled Jeffreys, and Richard R. Glover 30 Jun. 1966 87 p refs
(Grant AF-EOAR-65-18)
(AFOSR-66-2337; AD-640860) CFSTI: HC$3.00/MF$0.65

The report is a continuation of the work described in Reports AD-278 590 and AD-416 383. A simple 4 channel averaging system using a form of PFM for signal recording and a closed loop of magnetic tape as the accumulator is described and the experimental results of its application to the study of human evoked responses to patterned visual fields reported. The use of simple pulse coincidence circuitry for cross-correlation of E.E.G. signals is summarized. Author (TAB)

N67-19693# Aerospace Medical Div. Aeromedical Research Lab. (6571st), Holloman AFB, N. Mex.
VISUAL STIMULUS REDINTEGRATION IN THE CHIMPANZEE
Donald N. Farrer and Jim Milner Nov. 1966 22 p refs
(ARL-TR-66-19; AD-642836) CFSTI: HC$3.00/MF$0.65

Three chimpanzees, two males and one female, 92 to 104 months of age, were taught a visual match-the-sample task consisting of 24 problems. Following the demonstration that these subjects could memorize the rewarded stimulus in each of 24 configurations, each consisting of four stimuli, the subjects ability to continue to respond to the rewarded stimuli with one stimulus to two stimuli missing from each configuration was tested. The results demonstrated that the chimpanzee can successfully respond to visual stimulus and configurations that no longer contain all components on which the subject was originally trained. These results are discussed in terms of the amount and kind (i.e., rewarded vs. non-rewarded stimuli) of information required by the chimpanzee for the solution of a visual discrimination task, redintegration in the chimpanzee, and the cognitive capacity of the chimpanzee. Author (TAB)

N67-19703# Aerospace Medical Lab. (Clinical), Lackland AFB, Tex.
CONSTRUCTION AND USE OF AN INEXPENSIVE SMALL-ANIMAL TREADMILL Technical Report, Nov. 1965–Apr. 1966
Dominic Criscuolo and Kenneth H. Cooper Oct. 1966 13 p refs
(AMLC-TR-66-4; AD-642772) CFSTI: HC$3.00/MF$0.65

The design and construction of a 10-rat exercising treadmill is presented. Minimal shop facilities are required, and the cost does not exceed $200. An electric fence charger is used as a stimulus to induce the animals to keep running. The treadmill has been used to study the effect of exercise on the tissue level of rats exercised twice a day for 30 minute periods. The small-animal exerciser was used for 30 days without mechanical failure. Author (TAB)

N67-19754# Army Edgewood Arsenal, Md. Medical Research Lab.
REPETITIVE PSYCHOMETRIC MEASURES: EQUATING ALTERNATE FORMS. A REPLICATION Technical Report, Jun.–Dec. 1965
James J. Hart and Kragg P. Kysor Nov. 1966 14 p refs
(EATR-4049; AD-642164) CFSTI: HC$3.00/MF$0.65

An attempt was made to replicate the findings of others on form difficulty for two of the six Repetitive Psychometric Measures: the Number Facility subtest (NF) and the Speed of Closure subtest (SC). Tests were given to 207 volunteers to serially evaluate drug effects or other changes in performance for extended periods of time. The questions to be answered are: (1) How consistent are estimates of level of form difficulty for three samples of subjects. (2) How much correspondence is there between ranked level of difficulty as determined by others and as determined from the sample. (3) Does the application of a correction factor to another sample reduce the variability of the means of alternate forms. A significant degree of correspondence was found in the level of form difficulty of the NF and SC for three samples. There was a significant degree of correspondence between correction factors for the NF and SC obtained from these data and from those of other investigators. The use of correction factors obtained from one sample on the SC reduced both the range of the form means and their standard deviations when applied to another sample. Author (TAB)

N67-19761# Henry Ford Hospital, Detroit, Mich. Dept. of Neurological and Behavioral Sciences.
DYNAMICS OF RETICULAR AND LIMBIC POST STIMULUS DISCHARGE Progress Report
Lorne D. Proctor 1 Nov. 1966 19 p
(Grant AF-AFOSR-1037-66)
(AFOSR-66-2807; AD-643511) CFSTI: HC$3.00/MF$0.65

The reticular and limbic systems post stimulus discharges were observed further, using rats, cats and Nemestrina monkeys. The few microelectrode observations in rats and cats suggested this discharge is not a neural membrane phenomena. In three Nemestrina monkeys repeated stimulation and recording from macroelectrodes revealed the following: (1) The most reliable stimuli were 80% duty cycle square wave impulses with a frequency of 400 cps and voltages ranging from 6 - 15 volts with current flow of approximately 3.0 milliamperes for 10 seconds. The 80% duty cycle and 400 cps were critical parameters. (2) Stimulation in the amygdala produced 3 cps rhythmic discharges interrupted by high amplitude monophasic sharp waves or bursts of high amplitude biphasic waves in the stimulation electrode area and was usually reflected to the cortex. There was a residuum of this discharge even three days post stimulus. (3) Following some such stimulations there were large fluctuating DC shifts in the cortex and/or amygdala areas. Author (TAB)

N67-19771# Duke Univ., Durham, N. C.
BUFFER CONDITIONS IN EXPERIMENTAL STRESS
Kurt W. Back and Morton D. Bogdonoff Sep. 1966 16 p refs
(Contract Nonr-1181(11); Grants NIH G-M-5356; NIH G-MH-10896)
(TR-21; AD-640569) CFSTI: HC$3.00/MF$0.65

Reactions of subjects to the experimental situation was investigated by means of plasma free fatty acid level. Arousal (elevated FFA level) was shown at entry into the experiment, at the giving of instructions, and at upsetting experiences during the experiment. Stress at entry can be called experimental stress, variations within the experiment, manipulated stress. A series of conditions which insulate the subject socially, psychologically or physically from the situation diminish experimental stress and obliterate the differences in manipulated stress. They are: previous acquaintance, previous work together as a group, commitment to the experiment, and low height-weight ratio. Author (TAB)

N67-19776# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
BIOENERGETICS
King-Hwa Hsu 16 Sep. 1966 20 p refs Transl. into ENGLISH from Ti i Tz'u Ch'uan Kuo Sheng Wu Hua Hsueh Hsueh Shu Hui i Hui K'an (Communist China), no. 1, 1962 p 76–84
(FTD-TT-65-1495; TT-67-60277; AD-643953) CFSTI: HC $3.00/MF $0.65

Contents: Possible forms of energy changes in biological bodies; Thermodynamics and the phenomenon of life; Entropy and information in biological bodies; Energy barriers and entropy barriers. TAB

N67-19792# Philco Corp., Palo Alto, Calif.
ODOR CODING FOR MALFUNCTION DETECTION AND DIAGNOSIS Final Report, May 1965–Mar. 1966
Robert A. Goldbeck, Judith H. Kaeding, and W. E. Feroglia Wright-Patterson AFB, Ohio, AMRL, Aug. 1966 58 p refs
(Contract AF 33(615)-2948)
(AMRL-TR-66-122; AD-643239) CFSTI: HC $3.00/MF $0.65

The use of the olfactory sense for detecting and diagnosing malfunctions in equipment systems has been investigated. The literature on olfaction is reviewed and the data and data gaps relevant to equipment maintenance applications are summarized. With the literature findings as a point of reference, performance requirements for an odor-coding system are established and a taxonomic structure is synthesized for the purpose of developing specific odor-coding systems. A survey of equipment system applications leads to the conclusion that odor-augmented maintenance displays are both feasible and practical. Recommendations are made for a program of research and development leading to broad scope implementation of odor coding for malfunction detection and diagnosis. Author (TAB)

N67-19793# RAND Corp., Santa Monica, Calif.
PULSE TRAINS IN LATERAL GENICULATE AND RETINAL GANGLION NERVE CELLS
R. J. MacGregor Nov. 1966 65 p refs
(Contract ARPA SD-79; ARPA Order 189-1)
(RM-4870-ARPA; AD-644629) CFSTI: HC $3.00/MF $0.65

An examination was made of the relationship between the physical stimulus and the neuroelectric events involved in visual perception and discrimination. The data indicate that certain elemental relations of psychophysics reflect properties of retinal behavior. Electrical correlates of flicker fusion, intensity encoding, and spatial and temporal contrast are seen in the spike trains of ganglion cells. The concept that some psychophysical relations are mediated primarily in the retina, along with the neuroelectrical and neuroanatomical indications that centrifugal control at this level is small, suggests that the retina would be a promising point of entry for understanding some of the neural mechanisms subserving vision. Author (TAB)

N67-19812# Aerospace Medical Div. Aeromedical Research Lab. (6570th), Wright-Patterson AFB, Ohio.
THE NATURE AND CAPABILITIES OF THE CUTANEOUS SENSES
Billy M. Crawford and N. Katherine Copeland Barnes Jul. 1966 49 p refs
(AMRL-TR-66-108; AD-643266) CFSTI: HC $3.00/MF $0.65

Maintenance and operational personnel frequently obtain information concerning the status of their equipment and environment from other than visual or auditory cues. In many instances these cues were not intentionally provided for by the equipment designer. This report is based on the assumption that system performance can be significantly improved through planning and design for systematic use of man's 'secondary' sensory capabilities. The text of the report summarizes what is known about the cutaneous senses as they relate to troubleshooting, maintenance, and the more general problem of machine-to-man communication. Separate discussions are included for touch and pressure,vibration, temperature, moisture, oiliness, stickiness and texture. Characteristics of each sense are described in terms of theory, method of stimulation, stimulus dimensions and their perceptual correlates, the range through which stimuli are effective and useful, thresholds for detection and differentiation of stimuli, adaptation, and interactions with environmental conditions. The bibliography includes a relatively exhaustive set of references pertaining to the secondary senses, in general, i.e., smell and taste as well as the cutaneous senses. Author (TAB)

N67-19813# Aerospace Medical Div. Aerospace Medical Research Labs. (6570th), Wright-Patterson AFB, Ohio.
EVALUATION OF THE BIOCHEMICAL AND PHYSIOLOGICAL EFFECTS OF CONFINEMENT ON HUMAN SUBJECTS Final Report, Aug. 1963–Jun. 1966
K. J. Smith, Marilyn E. George, E. W. Speckmann (Miami Valley Hosp.), G. M. Homer, W. W. Blanchard et al Apr. 1966 47 p refs Prepared in cooperation with Miami Valley Hospital
(Contract AF 33(657)-11716)
(AMRL-TR-66-2; AD-644634) CFSTI: HC $3.00/MF $0.65

A series of experiments has been designed to determine the water, energy, and protein requirements of man under various simulated aerospace conditions. The reported 42-day experiment was designed to evaluate the effects of confinement on the nutritional, biochemical, and physiological status of human subjects in the Life Support Systems Evaluator. A freshly prepared diet that closely matched a proposed aerospace diet was fed to human volunteers, and coefficients of apparent digestibility and balance of the component nutrients were determined. The 4-day cycle menu composed of fresh, canned and heat processed foods was high in organoleptic acceptability. None of the foods became less acceptable with repeated servings. Confining the subjects for 28 days in the Life Support Systems Evaluator did not affect subject body weight, nutrient balance, digestion, or water balance. The values obtained for the nutrient balances indicated that the diet was efficiently digested and metabolized. Confinement to 2.4 square meters per man, in the Evaluator, had no effect on the hematological or physiological measurements. Author (TAB)

N67-19873* Dartmouth Coll., Hanover, N. H. Dept. of Biological Sciences.
THE EFFECT OF WEIGHTLESSNESS ON THE GROWTH AND ORIENTATION OF ROOTS AND SHOOTS OF MONOCOTYLEDONOUS SEEDLINGS Final Report, 1 Jul. 1964–30 Jun. 1966
Charles J. Lyon 30 Jul. 1966 45 p refs
(Contract NAS2-1558)
(NASA-CR-75092) CFSTI: $3.00 CSCL 06C

Grain seeds were sterilized, rinsed, immersed in distilled water for 4 hours, and finally inserted in plastic tubes containing a mixture of water and vermiculite. Assembled seed packages were then inserted in a temperature controlled clinostat; the absence of geotropical stimulation was simulated by turning the experimental package on a 2 rph horizontal axis. Measurements of coleoptiles and roots produced by growth, together with measurements of orientation angles for the seedling organs, showed a reasonably good consistency in orientation. The variations in length of the organs were not great enough to introduce unacceptable parameters in the angles; larger means of curvatures increased with the lengths of the coleoptiles. In the absence of gravitational stimulation, roots had a tendency to curve strongly in one direction; the side view angle of the primary root was recommended as criterion of the formative weightlessness effect for orbital experiments. G.G.

N67-19900*# National Aeronautics and Space Administration, Washington, D. C.
AEROSPACE MEDICINE AND BIOLOGY—A CONTINUING BIBLIOGRAPHY WITH INDEXES, JANUARY 1967
Feb. 1967 223 p refs
(NASA-SP-7011(34)) CFSTI: HC $3.00/MF $0.65 CSCL 06S

As part of a continuing bibliography on aerospace medicine and biology, a selection of annotated references is presented on the biological, physiological, psychological, and environmental effects to which man is subjected during the following simulated or actual flight in the earth's atmosphere or in interplanetary space. References describing similar effects on lower organisms are also included along with such related topics as sanitary problems, pharmacology, toxicology, safety and survival, life support systems, exobiology, and personnel factors. Emphasis is on applied research, but references to fundamental studies and theoretical principles related to experimental development are included. Subject, corporate source, and personal author indexes are appended. R.N.A.

N67-19902*# New York Univ., N. Y.
A DIFFUSION MODEL OF PERCEPTUAL MEMORY
R. A. Kinchla and F. Smyzer 30 Jan. 1967 34 p refs
(Grant NGR-33-016-067)
(NASA-CR-82958; I-67-1) CFSTI: HC $3.00/MF $0.65 CSCL 05J

A model is presented of the perceptual process through which an observer decides whether two stimuli are the same or different, with emphasis on the role of perceptual memory in such tasks. The results of two experiments, one visual and one auditory, are presented which illustrate the model's application and suggest its validity. Author

N67-19910# Advisory Group for Aerospace Research and Development, Paris (France).
AGARD INFORMATION BULLETIN, NO. 67-1
Jan. 1967 42 p refs
CFSTI: HC $3.00/MF $0.65

Reports of the Advisory Group for Aerospace Research and Development (AGARD) Panel activities and future plans are presented. These cover the fields of aerospace medicine, avionics, flight mechanics, fluid dynamics, guidance and control, propulsion and energetics, structures and materials, and technical information. Also included are descriptions of the AGARD lecture series and publications, and a calendar of AGARD meetings. R.N.A.

N67-19935* Naval School of Aviation Medicine, Pensacola, Fla.
ENERGY DISSIPATION CHARACTERISTICS IN TISSUE FOR IONIZING RADIATION IN SPACE Progress Report, 1 Dec. 1966–28 Feb. 1967
Hermann J. Schaefer 28 Feb. 1967 3 p
(NASA Order R-75)
(NASA-CR-82932; PR-17) CFSTI: HC $3.00 CSCL 06R

The question of how to treat the Bragg peaks of heavy nuclei terminating in tissue (so-called thindown hits) has been raised from an analysis of the rem dose equivalents. It is reported that work has been directed toward a clarification of the quantitative relationships governing the transition of thindown hits as they would follow from the latest information on the primary galactic spectrum during solar maximum and minimum. A.G.O.

N67-19947* Chicago Univ., Ill.
INTEGRATED RESEARCH AND TRAINING IN SPACE-MOLECULAR BIOLOGY Annual Progress Report, 1 Apr.–31 Dec. 1966
Humberto Fernandez-Moran 31 Dec. 1966 34 p refs
(Grant NsG-441-63)
(NASA-CR-82952) CFSTI: $3.00 CSCL 06C

Reports and summaries are presented of the following work: (1) contamination studies with samples recovered from a Luster micrometeorite sounding rocket experiment; (2) correlated electron microscopic and electron diffraction studies of certain meteorites and of pre-Cambrian organized systems; (3) high resolution electron microscopy with superconducting lenses at liquid helium temperatures; (4) development of improved instrumentation and preparation techniques for high resolution microscopy; and (5) studies on the subunit structure of membranes, including mitochondria, nerve membranes, and photoreceptors, and involving retinal rod outer segments, multienzyme complexes, fraction-I protein, and RNA-polymerase. An outline is also presented of organization and operation of special electron microscope laboratories in the biophysics department of the university. K.W.

N67-19955* California Univ., Berkeley. Space Sciences Lab.
ENZYME ACTIVITY IN TERRESTRIAL SOIL IN RELATION TO EXPLORATION OF THE MARTIAN SURFACE Semiannual Progress Report, 1 Jul.–31 Dec. 1966
J. J. Skujins and A. D. McLaren 12 Jan. 1967 74 p refs
Its Ser. no. 8, issue no. 2
(Grant NsG-704)
(NASA-CR-82944; SAPR-5) CFSTI: $3.00 CSCL 06M

The study objective is to develop tests for enzyme activities in soil and to adapt the most suitable of these to procedures compatible with telemetry from Mars probes. The investigation includes enzyme reactions in environments of limited water availability and at interfaces. An attempt was made to locate the microsites of soil phosphatase by electron microscopy. A study of surface effects in the hydrolysis of insoluble chitin by adsorbed chitinase and lysozyme is being conducted to investigate factors influencing reactions at interfaces. Studies of urea hydrolysis by urease in low-water media are described. The reaction is detectable at 65% relative humidity and the method is being developed for the detection of catalytic, i.e., enzymatic, breakdown of urea in Martian envirionment. A study of the initial metabolic steps of hydrocarbon degradation by terrestrial microorganisms was started. K.W.

N67-19983*# Massachusetts Inst. of Tech., Cambridge. Man-Vehicle Control Lab.
BIOPHYSICAL EVALUATION OF THE HUMAN VESTIBULAR SYSTEM Semiannual Status Report, 1 Jul.–31 Dec. 1966
J. L. Meiry and L. R. Young Jan. 1967 24 p refs
(Grant NGR-22-009-156)
(NASA-CR-82977; MV-67-2; SASR-2) CFSTI: HC $3.00/MF $0.65 CSCL 06P

The physical properties of the labyrinthine fluids and their variation with temperature were measured. A precision microviscometer was built and calibrated to measure viscosity of endolymph and perilymph. Progress in experiments and modeling of the vestibular caloric stimulation process is reported. Analytical efforts to establish a fluid dynamic model of the semicircular canals are discussed. Author

N67-19994* Pennsylvania State Univ., University Park. Biophysics Dept.
PHYSICS OF CELLULAR SYNTHESIS, GROWTH AND DIVISION Progress Status Report, 1 Jul.–31 Dec. 1966
E. C. Pollard 1 Mar. 1967 13 p refs
(Grant NsG-324)
(NASA-CR-82923) CFSTI: $3.00 CSCL 06C

Previous research in hyperchromicity, density gradients, and related topics is summarized, and details are given on current investigations. In order to study centrifugation of *E. coli* cells, an experiment was devised, using a polysaccharide material of high molecular weight. The experiment is described and the results discussed. It was concluded that either centrifugation does not force a rearrangement of the internal structure of the bacterial cell or the cell has the ability to function in spite of gross distortion. Preliminary experiments on the effect of radiation on banding position of bacterial cells in a CsCl density gradient are briefly reported; results indicated that gamma irradiation does alter the banding position. Investigation of the mechanism of T_4 replication in uv light-induced filamentous *E. coli* cells, using radioautographic techniques and genetic recombinational analysis, is briefly described. Finally, research in the effects of radiation on cultured mammalian cells is reviewed. L.E.W.

N67-20006# City of Hope Medical Center, Duarte, Calif.
FURTHER TOXICOLOGIC STUDIES OF ACUTE HYDRAZINE TOXICITY IN MICE, 1 JULY 1965–31 MARCH 1966
Eugene Roberts and Daisy G. Simonsen Brooks AFB, Tex., USAF School of Aerospace Medicine, Oct. 1966 18 p refs
(Contract AF 41(609)-2949)
(SAM-TR-66-89; AD-644027) CFSTI: HC $3.00/MF $0.65

Toxicologic studies of acute hydrazine toxicity in mice were continued. The results indicate that acute toxicity of hydrazine probably is not mediated through a histamine-release mechanism. Various experiments showed that the type of lethal seizure produced by hydrazine probably has no relationship to the sound-induced seizures in susceptible strains of mice. It was found that sodium phenobarbital had a marked protective effect against hydrazine toxicity when given in subhypnotic amounts. Sodium phenobarbital had an additive protective effect when it was administered together with the previously studied protective mixture (AGKO) containing arginine, glutamate, alpha-ketoglutarate, and oxalacetate. NaBr also was found to be protective and was found to act additively with either sodium phenobarbital or with the AGKO mixture. It was found in the course of the above experiments that imidazoleacetic acid, a substance not protecting mice against acute hydrazine toxicity, had interesting analgesic and hypnotic effects in mice. The quantitative aspects of these effects were worked out, and it is suggested that this agent should be explored further as a possibility for human use. Author (TAB)

N67-20145# Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany).
BIOLOGICAL–CHEMICAL RADIATION PROTECTION, II [BIOLOGISCH–CHEMISCHER STRAHLENSCHUTZ, II] Summary Report
R. Huber May 1966 28 p refs In GERMAN
(SZS-5/66)

A bibliographic review is presented of data on the effectiveness of various radioprotective substances. The radioprotective agents considered are SH compounds and derivatives, amines, amino acids, vitamins, hormones, and some unclassified compounds. NSA

05 BIOTECHNOLOGY

Includes life support systems, human engineering; protective clothing and equipment; crew training and evaluation, and piloting. For related information see also: 04 Biosciences.

N67-19417*# Republic Aviation Corp., Farmingdale, N. Y.
RESEARCH ON MICROMINIATURE PASSIVE TELEMETRY FOR BIOLOGICAL MEASUREMENTS Final Report
1 Dec. 1966 136 p refs
(Contract NASw-789)
(NASA-CR-82795; FHR-2901-5) CFSTI: HC $3.00/MF $0.65 CSCL 06B

The capabilities of physiological passive telemetry devices, used in living organisms to monitor vital biological functions, are briefly outlined. For application to waveforms such as heart muscle potentials, work in this program phase emphasized the development of a frequency modulation system to improve the signal-to-noise ratio, and range. The system works to the point where phase modulation can be demonstrated to show that an antenna excited with 8 and 12 megacycles receives the sum frequency of 20 megacycles which has been phase modulated by an audio frequency signal. The system processes the phase modulated signal, and the phase modulation itself can be displayed on an oscilloscope, or the modulating signal recovered in a phase detector and displayed as the desired intelligence waveform. Although a frequency modulation system was not considered efficient, significant progress was achieved. It was recommended, however, that completion of this FM system debugging would require funding for another research period. R.LI.

N67-19479*# Naval School of Aviation Medicine, Pensacola, Fla. Naval Aerospace Medical Center.
A TORQUE MOTOR SERVOROTATOR FOR VESTIBULAR APPLICATION
W. Carroll Hixson and Jorma I. Niven 26 Sep. 1966 20 p refs Joint Report with NASA
(NASA Order R-93)
(NASA-CR-82833; NAMI-979) CFSTI: HC $3.00/MF $0.65 CSCL 06L

The periodic angular rotator is a novel servorotator designed for studies of the dynamic response of the oculovestibular system. It will rotate a single subject about an earth-vertical axis in a wide variety of stimulus waveforms. Step function, ramp, and sinusoidal angular motions are generated precisely by a closed-loop power servomechanism drive system. The use of a low speed dc torque motor coupled directly to the payload resulted in a system with low acoustic noise and mechanical vibration properties, fast dynamic response characteristics, and a high degree of coupling stiffness. When operated in a velocity mode of control, the device is rated to produce a maximum angular velocity of 100 rpm either clockwise or counterclockwise at angular accelerations up to 100 deg/sq sec and sinusoidal oscillation frequencies beyond 2.0 cps. When operated in the alternative displacement mode, similar ratings apply over a plus or minus 150 degree excursion. Author (TAB)

N67-19559# Martin Co., Orlando, Fla.
EFFECT OF PERSPECTIVE GEOMETRY TRAINING ON TARGET AREA LOCATION Final Report, 1 Apr.–15 Oct. 1966
W. C. Hagen, M. A. Larue, and H. Ozkaptan Oct. 1966 64 p refs
(Contract N00014-66-C0150)
(OR-8528; AD-640712) CFSTI: HC $3.00/MF $0.65

A study was conducted to assess the value of training in perspective geometry on a subject's ability to locate target areas. Perspective geometry is defined as the study of spatial relationships on the ground and how they change when viewed from an oblique angle by means of a television system under simulated dynamic flight conditions. Simulation was accomplished by filming actual terrain from 2000 feet with a 28 degree field-of-view camera and projecting through a closed circuit TV system. Author (TAB)

N67-19701# Indiana Univ., Bloomington.
TESTS FOR THE EXTENT OF GENERALIZATION IN CLASSICAL CONDITIONING UNDER IDENTICAL TRAINING SCHEDULES
John J. Furedy Nov. 1966 15 p refs
(Contract Nonr-908-15)
(TR-16; AD-642781) CFSTI: HC $3.00/MF $0.65

The possibility that equal rates of reinforcement may produce generalization between two dissimilar conditioned stimuli is important both for understanding generalization itself and for interpreting null outcomes resulting from within-S comparisons of two conditioning methods. Conventional procedures for testing the extent of generalization are not applicable, but suitable trial arrangements do allow tests of this question, the number and nature of these tests depending on: (a) whether the reinforcement schedule is continuous or partial, and (b) whether conditioning can be measured on training trials. An application of one of the tests suggested that generalization of the conditioned GSR was total between a tone and a light. The statistical power of the tests under optimal trial arrangements is considered, and the implications of the result of the GSR study are discussed. Author (TAB)

N67-19716# Monsanto Research Corp., Dayton, Ohio.
IDENTIFICATION OF VOLATILE CONTAMINANTS OF SPACE CABIN MATERIALS Final Report, Jun. 1964–Sep. 1965
John V. Pustinger, Jr., F. Neil Hodgson, and William D. Ross Wright-Patterson AFB, Ohio, AMRL, Jun. 1966 209 p refs
(Contract AF 33(615)-1779)
(AMRL-TR-66-53; AD-642054) CFSTI: HC $3.00/MF $0.65

Fifty-five candidate materials for space cabin construction were stored for 30, 60, and 90 day periods at 23-25C, and 20-40% R.H. in environments of air at a pressure of one atmosphere and oxygen at 5 psia. The composition of the gas-off products were determined by mass spectrometry and gas chromatography. Additional analyses were performed on desorbates from four carbon canisters from space cabin simulators and the hydrolysis products of MCS 198. Author (TAB)

N67-19717# Texas Christian Univ., Fort Worth. Inst. of Behavioral Research.
GENERAL THEORETICAL PROBLEMS RELATED TO ORGANIZATIONAL TAXONOMY: A MODEL SOLUTION AND ITS ASSUMPTIONS
S. B. Sells 30 Sep. 1966 36 p refs Presented at the Symp. on People, Groups, and Organ., An Effective Integration of Knowledge; Sponsored by ONR and Rutgers Univ.
(Contract Nonr-3436(00))
(AD-642496) CFSTI: HC $3.00/MF $0.65

The report discusses the development of a social system model. Recognition that organizational functioning reflects the interdependence of organizations and their members with the total, physical, social, and cultural environment has been amply demonstrated. The emphasis on this principle is a sign of progress in organizational theory. TAB

N67-19787# Human Engineering Labs., Aberdeen Proving Ground, Md.
PACED REHEARSAL IN SEQUENTIAL SHORT-TERM MEMORY
Richard A. Monty, Robert Karsh, and Harvey A. Taub Nov. 1966 15 p refs
(TM-12-66; AD-643120) CFSTI: HC $3.00/MF $0.65

Subjects were required to mentally keep track of the number of occurrences of each of four different symbols presented sequentially. It was found that a green light introduced into the sequence just prior to the presentation of each successive symbol tended to enhance performance. It was suggested that the light served to cue the subjects to complete rehearsal of the current state of the information in preparation for the next stimulus in the sequence. Author (TAB)

N67-19788# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
PHYSICAL NATURE OF EXPLOITATION LIMITATIONS
A. M. Tarasenkov 30 Mar. 1966 16 p Transl. into ENGLISH from Vestn. Protivovozdushnoy Oborony (USSR), no. 5, 1964 p 45–48
(FTD-TT-65-1634; TT-67-60173; AD-643374) CFSTI: HC $3.00/MF $0.65

A report is presented of velocity and flight altitude limitations of supersonic aircraft, the angle of attack, as well as problems connected with distance limitation and flight continuation. TAB

N67-19790# American Inst. for Research, Washington, D. C.
THE EFFECTS OF DAILY GOAL-SETTING ON CODE RECEIVING PERFORMANCE AND ATTITUDES: A PILOT STUDY
Edwin A. Locke and Judith F. Bryan Oct. 1966 21 p
(AD-642784) CFSTI: HC $3.00/MF $0.65

One class at the Radioman A School at Bainbridge, Maryland (the Experimental group) set daily goals in terms of the score they would try for in code receiving. A second class (the Control group), run concurrently, did not set daily goals. It was found that the Experimental group improved their code receiving speed at a significantly faster rate than the Control group and made significantly fewer errors at speeds of 10 and 12 wpm than the group without daily goals. In addition, the Experimental group had significantly more favorable attitudes in code class than did the Control group on three of four attitude measures. The results, while promising, are not completely unequivocal, since there were a number of uncontrolled variables that might have affected the groups differently. Author (TAB)

N67-19955# Bucknell Univ., Lewisburg, Pa.
FEAR OF FAILURE AND COGNITIVE CONTROLS
Lawrence K. Lundwall and Richard C. Teevan 1966 31 p refs
(Contract Nonr-3591(01))
(TR-17; AD-641891) CFSTI: HC $3.00/MF $0.65

A review is given on studies and experiments on fear of failure and cognitive controls. TAB

N67-19858*# Douglas Aircraft Co., Inc., Santa Monica, Calif. Missile and Space Systems Div.
REPORT ON THE DEVELOPMENT OF THE MANNED ORBITAL RESEARCH LABORATORY (MORL) SYSTEM UTILIZATION POTENTIAL. TASK AREA IV:
T. D. Kennedy (Hamilton Std. Div., United Aircraft Corp.) and R. M. Byke Dec. 1965 160 p refs
(Contract NAS1-3612)
(NASA-CR-66289; SM-48816) CFSTI: HC $3.00/MF $0.65 CSCL 06K

This document contains a description of the environmental control life support (EC/LS) system studies performed in connection with the MORL system improvement study. The objectives of this task were as follows: (1) Modify the EC/LS system to correct any imitations or marginal capabilities identified as a result of the study of the expanded experimental plan and the mission development plan. (2) Identify new system elements stemming from advances in technology which will improve the EC/LS system and emphasize maximum system flexibility and growth capability. (3) Detail the research and technological development required. (4) Identify potential MORL support by the Apollo applications program through system development testing. Author

N67-19879*# Martin Co., Denver, Colo.
ENGINEERING STUDY AND EXPERIMENT DEFINITION FOR AN APOLLO APPLICATIONS PROGRAM EXPERIMENT ON VEHICLE DISTURBANCES DUE TO CREW ACTIVITY
J. R. Tewell and C. H. Murrish Mar. 1967 162 p Film Supplement No. L-954 to this Report is Available on Loan from Langley Res. Center
(Contract NAS1-6713)
(NASA-CR-66277) CFSTI: HC $3.00/MF $0.65 CSCL 05H

An Apollo Applications Program (AAP) flight experiment has been proposed to investigate crew motion disturbances. Typical crew motions were selected on the basis of frequency of occurrence during normal orbital operations and those activities associated with the AAP experiments. This report is presented in two parts, a technical report and a data supplement. The report outlines the selection of the crew motions studied, the analytic and direct simulation approaches, and defines the required instrumentation for an in-orbit experiment duplicating those activities studied. A detailed orbital experiment plan is also developed. As an illustration of the significant results of this study, it was found that the simple process of raising and lowering one arm can produce a change in attitude angle of 0.00075° (approximately 3 arc-sec) in a matter of 1 sec for uncontrolled space vehicles typical of the AAP. Author

N67-19880* Martin Co., Denver, Colo.
ENGINEERING STUDY AND EXPERIMENT DEFINITION FOR AN APOLLO APPLICATIONS PROGRAM EXPERIMENT ON VEHICLE DISTURBANCES DUE TO CREW ACTIVITY—DATA SUPPLEMENT
J. R. Tewell and C. H. Murrish Mar. 1967 253 p
(Contract NAS1-6713)
(NASA-CR-66277) CFSTI: $3.00 CSCL 05H

This appendix to the Apollo experiment on vehicle disturbances due to crew activities contains the data obtained in simulating translational activities as carried out on the six degree of freedom simulator (SOS). Forces, moments, and resulting spacecraft reactions from limb motions of test subjects were sampled by analog signals and converted to digital computation. of varying the distance between the spacecraft center of mass and the torso center of mass were also calculated. G.G.

N67-20251*# Louisville Univ., Ky. Performance Research Lab.
THE USE OF LOCATION AND LOCATION-INTENSITY PATTERNS IN ELECTROCUTANEOUS COMMUNICATION
Annual Report, 1 May 1965–30 Apr. 1966
Emerson Foulke and Thomas G. Sticht 26 Aug. 1966 61 p refs
(Grant NGR-18-002-007)
(NASA-CR-82857) CFSTI: HC $3.00/MF $0.65 CSCL 06B

Development and testing of electrocutaneous codes for general language communication and for improved information handling abilities is presented. The major objective was an electrocutaneous code for the communication of general language information at useful rates. In the encoding scheme employed, the representation of the elements in the Japanese Katakana Syllabary by electrocutaneous code signals required the use of patterns formed from 1,2 or 3 stimulated fingertip and palm locations. A group of signals was tested that included patterns composed of only one location; patterns of two locations on a single hand; and patterns with three locations, two on one hand and one on the other. The test consisted of requiring the subject to identify the stimulated location or locations that constituted the stimulus patterns. Studies were also performed to determine the relative discriminability of the onsets and offsets of electrical stimuli as indexed by reaction time at various intensities, frequencies, and rise-decay times. Where appropriate, underlying neurophysiological functions are suggested as explanations for psychophysical data. S.P.

06 CHEMISTRY

Includes chemical analysis and identification (e.g., spectroscopy). For applications see: 17 Materials, Metallic; 18 Materials, Nonmetallic; and 27 Propellants.

N67-19507*# Geological Survey, Washington, D. C.
THE SIMULTANEOUS DETERMINATION OF Cs, Hf, AND Ta BY NEUTRON ACTIVATION
Paul Greenland *In its* Astrogeol. Studies, Pt. C Oct. 1966 p 113–114 (See N67-19501 09-13) CFSTI: HC $3.00/MF $0.65

A neutron activation procedure is outlined that will simultaneously detect Cs, Hf, and Ta in tektite materials. Only Ta appears in a reasonably radiochemically pure state; contaminants are observed for the Cs and Hf fractions. Useful sensitivity limit of the procedure is about 0.01 ppm; and, although this is considered satisfactory for most samples, the limit could be lowered by increasing sample size and/or irradiation time. M.W.R.

N67-19508*# Geological Survey, Washington, D. C.
SPECTROGRAPHIC DETERMINATION OF ZINC AND SILVER IN SILICATES USING AN ARGON-D-C ARC
Charles S. Annell *In its* Astrogeol. Studies, Pt. C Oct. 1966 p 115–121 refs (See N67-19501 09-13) CFSTI: HC $3.00/MF $0.65

Analytical conditions, zinc standards, and silver determination are discussed in relation to a spectrographic method for the determination of trace concentrations of Ag and Zn in silicates by using an argon dc arc. Optimum spectrographic conditions requiring the least critical adjustments were determined from testing under various exposure conditions. Sets of zinc standards were prepared by successively diluting the standard granite and diabase with pure SiO_2 quartz, and also by using an opal glass standard with a recorded Zn concentration of 640 ppb. These silicates contain Zn

in a matrix approximating the chemical composition of tektite glasses. A series of standards in a pegmatite base matrix, containing as little as 0.215 ppm Ag, was arced under the same conditions used for the Zn determination. Since no modification of the Zn procedure is necessary, Ag can be determined to as low as 0.2 ppm at the same time. M.W.R.

N67-19510# Oak Ridge National Lab., Tenn.
UNIT OPERATIONS SECTION Quarterly Progress Report, Jan.–Mar. 1966
Sep. 1966 79 p refs
(Contract W-7405-ENG-26)
(ORNL-3995) CFSTI: HC $3.00/MF $0.65

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4. SOL-GEL PROCESS DEVELOPMENT P. A. Haas et al p 29–35 refs (See N67-19514 09-06)
5. FLUORIDE VOLATILITY PROCESSING R. W. Horton p 36–70 (See N67-19515 09-06)

N67-19511# Oak Ridge National Lab., Tenn.
CHEMICAL ENGINEERING RESEARCH
W. S. Groenier and M. E. Whatley *In its* Unit Operations Sect. Sep. 1966 p 4–20 ref (See N67-19510 09-06) CFSTI: HC $3.00/MF $0.65

Recently, the experimental stacked-clone solvent-extraction contractor has been operated with the organic phase continuous. All previous work was done with the aqueous phase continuous. Demonstration of the organic continuous mode of solvent extraction extends the range of usefulness of the contactor to allow operation at very low aqueous:organic flow ratios and with highly viscous aqueous solutions. Organic continuous dispersions were produced, and flooding throughputs were measured for a variety of chemical systems including Amsco–0.08 M HNO_3, Amsco–66 wt % glycerine, and Amsco–38.5 wt % dextrose. Mass transfer of uranium was measured for 5% TBP–Amsco–1 M $NaNO_3$ system. Finally, the effect of sudden injections of particulate impurities on contactor operation was noted for both aqueous- and organic-continuous modes of operation. Author (NSA)

N67-19513# Oak Ridge National Lab., Tenn.
THORIUM FUEL-CYCLE STUDIES
P. A. Haas et al *In its* Unit Operations Sect. Sep. 1966 p 22–28 (See N67-19510 09-06) CFSTI: HC $3.00/MF $0.65

Development of sol-gel processes for recycling thorium and uranium to heterogeneous reactors has continued, with emphasis on the preparation of oxide spherules. Cracking of the oxide microspheres during firing depends on the gel-drying conditions and is more troublesome for larger microspheres. The presence of superheated steam in the drying atmosphere as the temperature increases from 100 to 200°C aids in removing 2-ethyl-1-hexanol from the gel and reduces the amount of cracking during firing. A pilot-plant-scale microsphere column system was operated at rates up to 1200 g of ThO_2 per hour to produce microspheres for pyrolytic-carbon-coating studies. The microspheres were in two size ranges: 210 to 250 μ, and from 420 to 500. Operation of the column was good, but operation of the auxiliary equipment was less satisfactory. Author (NSA)

N67-19514# Oak Ridge National Lab., Tenn.
SOL-GEL PROCESS DEVELOPMENT
P. A. Haas et al *In its* Unit Operations Sect. Sep. 1966 p 29–35 refs (See N67-19510 09-06) CFSTI: HC $3.00/MF $0.65

Engineering studies of urania-sol preparation were continued as part of the sol-gel process development for preparing ceramic fuel mixtures. The photochemical reduction of UO_2^{2+} to U^{4+} in uranyl nitrate solution by hydrazine or formaldehyde was never more than 46% complete; no further work is planned. The direct catalyzed reduction of uranyl formate suspensions (one-step process) gave 70% conversion of the uranium to urania sols in 4 to 5 hr. Conditioning of the platinum catalyst (adsorption of hydrogen on wetted catalyst) was necessary. Higher yields and lower formate:urania ratios would be required to make this procedure attractive, compared with others. The equipment and procedures proposed for use in glove boxes to prepare UO_2–PuO_2 microspheres were successfully tested with depleted UO_2 sols. Author (NSA)

N67-19515# Oak Ridge National Lab., Tenn.
FLUORIDE VOLATILITY PROCESSING
R. W. Horton et al *In its* Unit Operations Sect. Sep. 1966 p 36–70 (See N67-19510 09-06) CFSTI: HC $3.00/MF $0.65

Four tests were made of the HF–O_2 decladding process; one was successful and three were not. The explanation for the unsuccessful tests is not yet known. Heating-rate experiments indicate that the fuel element reaches reaction temperature readily with any one of several fluidizing bed materials. When the oxides, left after decladding, were fluorinated, 99.6% of the uranium was volatilized from the fluidized bed. Requirements have been established for in-line analytical instruments. A gas chromatograph and an ultraviolet spectrophotometer are now installed. Data taken by these two instruments during process and calibration runs are shown. A method was considered for using the delayed neutron flux from plutonium following a neutron irradiation burst to detect the presence of residual plutonium in the reactor waste. From a radiation experiment and from published values of the concentration of transplutonium elements that would produce an interfering neutron flux, it was concluded that the method is not likely to justify the development and installation cost. Author (NSA)

N67-19526# California Univ., Berkeley. Lawrence Radiation Lab.
SOME ANALYTICAL RESULTS IN ORGANIC GEOCHEMISTRY.
Theodore Belsky, Eugene D. McCarthy, and William Van Hoeven *In its* Chem. Biodyn. Ann. Report, 1965 Mar. 1966 p 53 refs (See N67-19521 09-04) CFSTI: HC $3.00/MF $0.65

Isoprenoid alkanes are being used as "biological markers" in a quest for evidence of life among geological well-characterized ancient shales and oils. The results of previous studies are briefly discussed, and it is pointed out that the occurrence of steranes in shale areas provides evidence for the presence of life processes sufficiently complex to require an enzymatic template and *in vivo* polyisoprenoid cyclizations at the 2-billion-year mark in terrestrial chronology. Preliminary results from analyses of the Pierre Shale (Late Cretaceous Period) and from Mud Lake, Florida, are examined with emphasis placed on the diagenetic processes that take place in the sediments. A.G.O.

N67-19546# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
SYNTHESIS AND PROPERTIES OF 1-SILYL-4-(VINYLSILYL) BENZENES

E. N. Znamenskaya and N. S. Nametkin 6 Apr. 1966 16 p refs Transl. into ENGLISH from Neftekhim. (Moscow), v. 4, no. 3, 1964 p 487–493
(FTD-TT-65-1665; TT-66-62415; AD-640250) CFSTI: HC $3.00/MF $0.65

There were obtained two vinylhydride-n-phenylene-disilanes not described in the literature: 1-diethylsilyl-4-diethylvinylsilyl and 1-methylphaylsilyl-4-methylphenylvinylsilyl-benzene (I). By use of the example of I the possibility of polymerization of vinylhydride-n-phenylenedisilanes is demonstrated. The polymerization of I, in the presence of Pt/C and by the thermal method without a catalyst, takes place with the formation of linear soluble polymers with silicon–phenylene–silicon–carbon chains, which was established by the method of investigation of the infrared absorption spectra. Author (TAB)

N67-19558# Johns Hopkins Univ., Baltimore, Md. Dept. of Physics
DIRECT EVIDENCE FOR AND TRANSITION RATES OF ION PAIR INTERACTIONS IN $LaCl_3$: Ho^{3+}
J. F. Porter, Jr. and H. W. Moos [1965] 27 p refs
(Contract DA-31-124-ARO(D)-103)
(AD-640612) CFSTI: HC $3.00/MF $0.65

Energy transfer between Ho(3+) ions in a LaC13 lattice was studied by means of relative fluorescence intensity measurements. By careful measurements of the relative fluorescence from E(5S2), C5I4), and Y(5I7) it was demonstrated that to within the experimental error, E relaxes to C only by an ion pair process. The concentration dependence of the pair process is linear. Assuming a simple model with a sharp radial drop off, an effective range of 7.5A (3rd nearest neighbor) was found for the ion pair interaction. Author (TAB)

N67-19582*# General Electric Co., Pleasanton, Calif. Atomic Power Equipment Dept.
THE CURRENT STATE OF THE ART OF ALKALI METAL ANALYSIS
D. Dutina *In* AEC AEC–NASA Liquid Metals Inform. Meeting 23 Apr. 1965 p 1–15 refs (See N67-19581 09-17) CFSTI: HC $3.00/MF $0.65

Analytical laboratory methods for the determination of total amounts of nitrogen, hydrogen, oxygen, and carbon in sodium, especially in concentrations greater than 10 ppm were reviewed. Emphasis was placed on the effects that combinations of the above elements with each other, or with other elements, may have on the reliability of the methods applied. Determination methods for nitrogen are all modifications of the Kjeldahl technique; the nitrogen present is converted to ammonia, distilled out, and determined by titration. Gaseous diffusion techniques, and amalgamation methods are applied to determine hydrogen. The mercury amalgamation technique is the most commonly used technique for oxygen analysis; however, vacuum distillation and gettering vacuum fusion methods are gaining popularity. At least nine analytical methods are described for the determination of carbon in liquid metals; all convert carbon to a gaseous form and later use sensitive instrumental techniques to quantitatively estimate the gas. Combined forms of impurities are treated by mercury amalgamation, solution in liquid ammonia, and distillation for separation from large samples of sodium. G.G.

N67-19583*# United Nuclear Corp., White Plains, N. Y. Development Div.
DEVELOPMENT OF ELECTROCHEMICAL METHODS FOR OXYGEN MONITORING AND REMOVAL IN SODIUM
B. Minushkin and J. Mc Kee *In* AEC AEC–NASA Liquid Metals Inform. Meeting 23 Apr. 1965 p 16–34 refs (See N67-19581 09-17) CFSTI: HC $3.00/MF $0.65
(Contracts AT(30-1)-2877; AF 33(615)-1039)

Described is the development and performance of an electrochemical oxygen meter suitable for use in sodium test systems. The device is a solid electrolyte galvanic cell containing zirconia or thoria based on electrolyte, characterized by a crystal structure with oxygen vacancies that develop an emf potential when placed between oxygen dissolved in sodium and a metal oxide reference electrode. This meter is useful at the low level oxygen anticipated in gettering sodium and sensitive to small changes in oxygen content. Also demonstrated is the removal of oxygen by application of voltage across a cell containing solid zirconium oxide + 8 m/o calcium oxide electrolyte. Performance tests with the cell immersed in flowing sodium at the hottest point of a thermal convection loop show a good reaction rate of sodium with the solid electrolyte at a voltage gradient of 4 to 6 volts/mm; about 200 cc of oxygen were removed at an average current efficiency of 16.5% in 120 hrs. G.G.

N67-19584*# Atomics International, Canoga Park, Calif.
SOLUBILITY AND DIFFUSION STUDIES OF ULTRA PURE TRANSITION ELEMENTS IN ULTRA PURE ALKALI METALS Status Summary Report
R. L. McKisson and R. L. Eichelberger *In* AEC AEC–NASA Liquid Metals Inform. Meeting 23 Apr. 1965 p 37–42 ref (See N67-19581 09-17) CFSTI: HC $3.00/MF $0.65
(Contract NAS3-4163)

Solubilities and rates of solution of highly purified refractory metals and compounds in potassium were studied by filtration, hot gettering, and vacuum friction distillation in five sequentially connected high vacuum chambers at a working level of $<10^{-8}$ Torr. Refractory metal samples were prepared by electrochemical machining, encapsulated together with a nominal 1.5 g potassium sample, and subjected to timed exposure at 600 to 1200°C temperatures. Experimental data for the solution of iron in potassium are plotted as log iron concentration corresponding to a solution of 23,000 cal/mol. Also presented in table form are solution data for molybdenum. G.G.

N67-19585*# Douglas Aircraft Co., Inc., Santa Monica, Calif.
SOLUBILITY OF TRANSITION METALS IN MOLTEN POTASSIUM
W. S. Ginell and R. J. Teitel *In* AEC AEC–NASA Liquid Metals Inform. Meeting 23 Apr. 1965 p 44–47 (See N67-19581 09-17) CFSTI: HC $3.00/MF $0.65

In order to minimize the experimental problems related to controlling the variables, a technique for solubility determinations was evolved. Initial experiments are being conducted on niobium and tantalum in potassium within the temperature range of 1100° to 1400°C. The potassium is purified by contact with Ti–Zr alloy chips at 785°C for 24 hours. Before filling, the entire capsule is out-gassed in an ion-pumped high temperature furnace; the potassium filling operation is performed in a purified argon atmosphere dry box. A reproducible, known quantity of molten potassium is transferred from the hot trap directly into an L shaped capsule, and then welded closed. A diagram of the test capsule is included. Initially, the capsules were subjected to one hour at a temperature 100°C above the equilibration temperature; one hour at low centrifugal speed (4 G) at the equilibration temperature; and three hours at high centrifugal speed (50 to 70 G) at the same temperature. Later, the equilibration time was increased to three hours and the centrifugation time to six hours. Tabulated data show the results obtained. M.G.J.

N67-19586*# Pratt and Whitney Aircraft, Middletown, Conn. CANEL Div.
SOLUBILITY STUDIES IN ALKALI METALS
S. S. Blecherman, G. F. Schenck, and R. E. Cleary *In* AEC AEC–NASA Liquid Metals Inform. Meeting 23 Apr. 1965 p 48–53 refs (See N67-19581 09-17) CFSTI: HC $3.00/MF $0.65
(Contract AT(30-1)-2789)

Data are presented on experiments conducted to determine the solubility parameters for metals in lithium and in potassium. In the niobium in lithium tests, more than 30 capsules with and without added lithium oxide and nitride were tested from 760° to 1425°C. All solubility capsules were held at temperature for 50 hours. Post-test analysis of the lithium showed no effect of nitride additions to 0.5% and oxide additions to 1%; however, there was considerable scatter of the data. Temperature dependence of solubility for niobium in lithium appears small over the 760° to 1540°C range. Data on the niobium–potassium system indicates that the solubility of niobium in purified potassium is below 20 parts per million up to 1200°C, and that additions of up to 2000 ppm oxygen were within the scatter of data from purified potassium. Additions of 5000 ppm oxygen had a marked effect on the apparent solubility. Preliminary results from other tests infer that the zirconium and niobium solubilities in lithium may have the same order of magnitude. Graphical data on calcium solubility in eutectic NaK alloy are also presented. M.G.J.

N67-19590*# Atomics International, Canoga Park, Calif.
POTASSIUM PURIFICATION
R. L. McKisson *In* AEC AEC–NASA Liquid Metals Inform. Meeting 23 Apr. 1965 p 75–78 ref (See N67-19581 09-17) CFSTI: HC $3.00/MF $0.65
(Contract NAS3-4163)

A three-step purification process, consisting of filtration, hot gettering, and vacuum fractional distillation, is discussed. As cesium and rubidium tend to concentrate in the vapor, the first fraction of the distillate is discarded in order to reduce the amount of these metals in the product. The middle fraction is collected as the purified product, and the third fraction, containing most of the sodium, lithium, and other metallic impurities, remains in the still pot. Impurity analyses show that the process is effective in reducing the levels of Al, Ca, Cr, Cu, Fe, Mg, Mn, Na, Ni, Si, and O. M.G.J.

N67-19618# Naval Radiological Defense Lab., San Francisco, Calif.
THE PAPER ELECTROPHORESIS OF THE IRON (II)–IRON (III) SYSTEM
Wesley E. Lingren, Gerald Reeck, and Ronald Marson 26 Sep. 1966 14 p refs
(Contract AT(49-5)-2084(2))
(USNRDL-TRC-84; AD-644002) CFSTI: HC $3.00/MF $0.65

The iron(II) - iron(III) equilibrium mixture in a sulfuric acid solution of pH 2.6 is separable by paper electrophoresis. An attempt was made to determine whether the electrophoretic system affected this equilibrium. Maximum differences of about 10% from the iron(II) - iron(III) true equilibrium ratio were observed after the separation by paper electrophoresis. Author (TAB)

N67-19649# Institute of Modern Languages, Inc., Washington, D. C.
THE LUMINESCENCE OF RARE-EARTH PHTHALOCYANINES
M. G. Gurevich and K. N. Solov'yev Ft. Belvoir, Va., Army Eng. Res. and Develop. Labs., Aug. 1966 10 p refs Transl. into ENGLISH from Dokl. Akad. Nauk SSSR (Moscow), v. 7, no. 7, 1964 p 291–294
(Contract DA-44-009-AMC-1563(T))
(T-1864-66; ERDL-202858; AD-641272) CFSTI: HC $3.00/MF $0.65

Rare earth phthalocyanine complexes were obtained by the action of ortho-cyanbenzamide on rare earth halides. The spectral luminescence characteristics of the compounds are reported. Evidence was obtained indicating intramolecular energy migration in a porphyrin ring. TAB

N67-19676# Air Force Cambridge Research Labs., Bedford, Mass. Solid State Sciences Lab.
THE PREPARATION AND CHARACTERIZATION OF DIRECT CURRENT AND SYMMETRIC PERIODIC REVERSE CURRENT ELECTRODEPOSITS OF EPITAXIAL COPPER
John J. O'Connor, Bernard Rubin, and Reynold Spector Aug. 1966 21 p refs *Its* Phys. Sci. Res. Papers No. 258
(AFCRL-66-538; AD-640643) CFSTI: HC $3.00/MF $0.65

Single crystal epitaxial deposits of copper have been electrodeposited on (100) oriented single-crystal copper substrates using both direct current and asymmetric periodic reverse current methods. It was found that the degree of crystalline perfection is approximately the same for both methods and reflects the substrate perfection. The epitaxial growth and perfection of the deposits are not appreciably affected by dissolved lead impurities in the electrolyte over the range 0.25 to 100 parts per million of lead. The reverse current deposits have a considerably larger crystallite size which is attributed to a lower effective rate of nucleation. Author (TAB)

N67-19687# Naval Research Lab., Washington, D. C.
PREPARATION AND CHARACTERIZATION OF ULTRA-PURE SOLIDS Annual Report, 1 Jul. 1965–30 Jun. 1966
C. C. Klick, G. T. Rado, M. R. Achter, and A. I. Schindler 1966 98 p refs
(ARPA Order 418)
(NRL-MR-1718; AD-641958) CFSTI: HC $3.00/MF $0.65

Contents: Alkali halide crystals, with emphasis on potassium bromide (Physical methods of purification, Chemical methods of purification, Crystal growth, Characterization and analysis); Refractory metal crystals (Growth and characterization of single crystals of niobium, Crystallography of bicrystals Sintering of intergranular porosity in bicrystals, Grain boundary energy, Grain boundary self-diffusion in niobium); Transition metal and intermetallic compound single crystals (Properties of liquid metals, Production and purification of Nb single crystals, low temperature thermal conductivity of hafnium, magnetoacoustic oscillations in single crystal copper); Magnetic materials (Crystal synthesis of A2BF4 and Ga2−xFexO3, Crystal characterization of K2CoF4, K2ZnF4; Co (2+) doped Al2O3, and Fe (3+) doped beta-G-a2O3. TAB

N67-19690# Cornell Univ., Ithaca, N. Y. Materials Science Center.
F-CENTER FORMATION BY UV IRRADIATION IN SEVERAL MIXED AND PURE ALKALI HALIDES, AND A STUDY OF THE ICL^{-} VK^{-} CENTER IN KCL(I)
Lawrence Spencer Goldberg (Ph.D. Thesis) Sep. 1966 162 p refs Sponsored by ARPA and ONR
(MSC-517; AD-643489) CFSTI: HC $3.00/MF $0.65

The process of F-center formation by exciton uv irradiation has been studied in KC1(I), KBr(I), KI, and RbI. Experiments were

performed principally in the mixed crystal KC1(I), a system which affords considerable experimental advantages for detailed studies. A selected number of experiments were carried out in the pure alkali iodides, KI and RbI, and the results show striking similarities with those obtained for KC1(I), indicating that the mechanism of defect formation in the mixed and pure crystal systems is closely analogous. This mechanism is considered to be a thermally activated decomposition of a relaxed excited state configuration of the I(-)ion, resulting in an intrinsic introduction of vacancy-interstitial pairs into the lattice, as evidenced by F and V-center growth. Author (TAB)

N67-19696# Calvin Coll., Grand Rapids, Mich. Dept. of Chemistry.

MAGNETIC SUSCEPTIBILITY OF AGO

Thedford P. Dirkse 1 Nov. 1966 16 p refs

(Contract Nonr-1682(02))

(TR-5; AD-642850) CFSTI: HC $3.00/MF $0.65

A lengthy review is given of the case for the existence of compounds containing tripositive silver. Alternate explanations are also given, the most common one being the existence of peroxides. The argument for the presence of tripositive silver in AgO rests heavily on the diamagnetism of AgO. Several samples of AgO were prepared and most of them were diamagnetic. Metallic silver is also diamagnetic. This raises doubts about the validity of magnetic susceptibility as evidence for the existence of tripositive silver in AgO. Author (TAB)

N67-19718# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

THE APPLICATION OF ELECTRON MAGNETIC RESONANCE IN CATALYSIS RESEARCH

Kwang-Tse Hsu 21 Nov. 1966 15 p refs Transl. into ENGLISH from Hua Hsueh Shih Chieh (Peking), v. 18, no. 6, 1964 p 243–245

(FTD-TT-65-1873; TT-67-60188; AD-643599) CFSTI: HC $3.00/MF $0.65

The application of electron paramagnetic resonance in catalysis research has principally two aspects: the first one is the shape of the resonance spectrum its structure and the determination of the electronic configuration and the chemical composition of paramagnetic catalysts following the changes introduced by different treatments of the catalyst. The second concerns the determination of the structure and nature of the free radicals produced during a reaction or in an adsorption process and the nature of their bonding with the catalyst from which one can derive the basis and the clues to the reaction mechanism involved. The theory and applications of electron magnetic resonance have been discussed previously. This article deals only with its application in catalysis research. Author (TAB)

N67-19730# Picatinny Arsenal, Dover, N. J. Plastics Technical Evaluation Center.

FERROCENE POLYMERS: AN ANNOTATED BIBLIOGRAPHY

David W. Levi Sep. 1966 33 p refs

(PLASTEC-15; AD-643025) CFSTI: HC $3.00/MF $0.65

An annotated bibliography of 46 items is reported on ferrocene polymers. It is limited to the references in the authors personal file. However, these cover the significant journals in the field, for the period 1956-1966. Complete subject and author indexes are included. Author (TAB)

N67-19734# Olin Mathieson Chemical Corp., New Haven, Conn. Chemicals Div.

ALKYL AND ARYL ALUMINUM COMPLEXES. I: THE REACTION OF TRIALKYL AND TRIARYL ALUMINUM WITH BIDENTATE LIGANDS

Thomas J. Hurley, Martin A. Robinson, James A. Scruggs, and Samuel I. Trotz 31 Oct. 1966 14 p refs

(Contract Nonr-5039(00))

(TR-1; AD-642608) CFSTI: HC $3.00/MF $0.65

A series of dialkyl and diarylaluminum complexes were prepared through the reactions of trialkyl- and tirarylaluminum compounds with bidentate ligands featuring hydroxyl and amine functionality. The dimeric nature of these compounds is explained on the basis of stereochemical considerations and NMR and infrared spectroscopy, concluding that, in all but one case, bridging is through the nitrogen and oxygen atoms of the bidentate ligand. Author (TAB)

N67-19748# Naval Radiological Defense Lab., San Francisco, Calif.

ION EXCHANGE IN FUSED SALTS. III: THE CATION EXCHANGE CHARACTERISTICS OF SOME BORATE, BOROSILICATE, AND BOROPHOSPHATE GLASSES IN FUSED SODIUM NITRATE

Monte H. Rowell 13 Sep. 1966 33 p refs

(Contract AT(49-2)-1167)

(USNRDL-TR-1091; AD-643231) CFSTI: HC $3.00/MF $0.65

Six glasses, comprised of two alkali borates, two salt-loaded alkali borates, one low-silica borosilicate, and one borophosphate, were prepared and tested as ion exchangers for use with fused-salt solvents. These high-alkali borate glasses, including the salt-loaded ones, showed excellent selectivity among Cs, Na, Sr, Ba, and Eu in molten NaNOe, and appear to be more generally effective as ion exchangers in fused salts than any material previously tested. Inclusion of NaCl to the limit of its solubility in alkali borate glass greatly improved the rate of ion diffusion in the glass, thus removing the major drawback of glasses as ion exchangers. Inclusion of Na2SO4 did not have the same beneficial effect as that of NaCl. The borosilicate and borophosphate glasses tested did not show as good ion-exchange characteristics as did the pure alkali borates. High-alkali borate glasses showed selectivity for cations in the order of increasing field strength of the cation. The selectivity behavior provides information about the nature of the ion-exchange process in fused salts. Author (TAB)

N67-19757# Ohio State Univ., Columbus. Aeronautical and Astronautical Research Lab.

SHOCK TUBES STUDY OF THE DISSOCIATION OF CARBON DIOXIDE

E. S. Fishburne, K. R. Bilwakesh, and R. Edse Wright-Patterson AFB, Ohio, ARL, Jun. 1966 29 p refs

(Contract AF 33(657)-8951)

(ARL-66-0116; TR-6; AD-642300) CFSTI: HC $3.00/MF $0.65

The rate of dissociation of carbon dioxide in an excess of argon or nitrogen has been measured in the temperature range 3300K - 5000K. A shock tube was used to heat the gas mixture which contained from 1% to 10% carbon dioxide. It is shown that the decrease in temperature and the increase in density due to the endothermic dissociation must be considered to obtain reliable results. The total concentration of the gas mixture was varied from 0.000011 to 0.00000486 moles/cc. The rate constants were determined to be k1,A = (7.11 x 10 to the 11th power) T to the 1/2 power exp(-84,500/RT) cc/mole sec when argon was used as the diluent; and k1,N2 = (5.33 x 10 to the 11th power) T to the 1/2 power exp(-79,600/RT) cc/mole sec when nitrogen was used as the diluent. The probable dissociation mechanism also is discussed. Author (TAB)

N67-19785# Georgetown Univ., Washington, D. C. Dept. of Chemistry.
REACTIONS OF METALLIC IONS Final Technical Report, Period Ending Oct. 2, 1966
Joseph E. Earley Nov. 1966 6 p refs
(Grant AF-AFOSR-133-65)
(AF-133-65; AFOSR-66-2767; AD-643436) CFSTI: HC $3.00/MF $0.65

The project was concerned with an investigation of the kinetics and mechanisms of important reactions of inorganic species in aqueous solutions especially those complexes of chromium and cobalt. A study was made on the polarographic studies of Cr(C2O4)(H2O)4(+). Several mechanisms of electron-transfer reactions were elucidated in solution, and different mechaniams were explained at the dropping mercury electrode. A state of the art review on the chemistry of chromium III was published. Author (TAB)

N67-19794# Naval Research Lab., Washington, D. C.
PROCEDURES FOR THE ANALYSIS OF METALS, ALLOYS, AND OTHER MATERIALS OF RESEARCH. PART 2: DETERMINATION OF SILVER AND IDIUM IN MAGNESIUM-BASE ALLOYS, LEAD IN INDIUM, AND ZIRCONIUM IN HAFNIUM
O. R. Gates and E. J. Brooks 28 Sep. 1966 18 p ref
(NRL-6427; AD-644586) CFSTI: HC $3.00/MF $0.65

A series of methods is presented in sufficient detail for direct analytical application to the determination of silver and indium in magnesium-base alloys, lead in indium, and zirconium in hafnium. The analytical approaches are combinations of chemical and instrumental techniques involving the flame spectrophotometer, the polarograph, and the x-ray fluorescence equipment, respectively. TAB

N67-19796# Rock Island Arsenal Lab., Ill. Research and Engineering Div.
GAS CHROMATOGRAPHIC ANALYSIS OF THE PYROLYSIS PRODUCTS OF ORGANIC MATERIALS
Thomas A. Turner and Stanley L. Eisler Oct. 1966 19 p refs
(RIA-66-3171; AD-644648) CFSTI: HC $3.00/MF $0.65

Gas chromatographs of the pyrolysis products of three styrene polymers, having molecular weights of 20,000; 35,000 and 230,000 were prepared. Peaks were identified for benzene, toluene, and monomeric styrene. Another peak was obtained which was assumed to be acetylene, ethylene, or a combination of the two. Peak area analysis revealed no significant difference between the polymers at the same pyrolysis temperature but an increase in the amount of lighter gaseous components at the higher pyrolysis temperature. This investigation has indicated that gas chromatographic analysis of pyrolysis products may be potentially useful for the characterization of lubricants, paints, plastics and other materials used by the Department of the Army. Author (TAB)

N67-19807# IIT Research Inst., Chicago, Ill. Dept. of Chemistry.
NORMAL COORDINATE ANALYSES OF HYDROGEN-BONDED COMPOUNDS Final Report, Sep. 1962–Nov. 1966
Kazuo Nakamoto 31 Nov. 1966 10 p refs
(Contract DA-31-124-ARO(D)-38)
(AROD-3899-8; AD-644199) CFSTI: HC $3.00/MF $0.65

A summary is given of a research program in which the vibrational spectra of relatively simple hydrogen-bonded compounds were investigated by using the method of normal coordinate analysis. Monomeric and dimeric formic acid and acetic acid, the acid maleate ion, the acid carbonate ion, and the enol-forms of acetylecetone and hexafluoroacetylacetone were among the subjects studied. Author (TAB)

N67-19828# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
ENERGY SPECTRUM π-ELECTRONS IN LONG CHAINS OF CONJUGATE BONDS
Pai-Ling Hao, Te-Shen Liu, and Shik-Kan Chien 15 Aug. 1966 27 p refs Transl. into ENGLISH from Scientia Sinica (Peking), v. 10, n. 6, 1961 p 653–675
(FTD-MT-66-27; AD-643961) CFSTI: HC $3.00/MF $0.65

This work is devoted to the LCAO-MO method on infinitely long periodic structures and the electron energy spectra of certain ideal macromolecules with a system of conjugated bonds are studied. Special attention is paid to the close contact of the spectrum with structure and to the wide possibility of chemical synthesis. Author (TAB)

N67-19847# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
EFFECT OF THE DEGREE OF ELONGATION OF POLYMETHYLMETHACRYLATE (PMMA) ON THE MAGNITUDE OF THE SECOND MOMENTS OF A NUCLEAR MAGNETIC RESONANCE SPECTRUM (YAMR)
N. M. Kocharyan, A. P. Pikalov et al 29 Jul. 1966 10 p refs Transl. into ENGLISH from Dokl. Akad. Nauk Arm. SSR (Erevan), v. 40, no. 1, 1965 p 25–29
(FTD-TT-65-2007; TT-67-60253; AD-643729) CFSTI: HC $3.00/MF $0.65

An autodyne NMR spectrometer was designed which incorporates a quartz frequency stabilization system in order to avoid difficulties inherent in systems requiring the working sample to be placed in the resonator coil. The device was used to investigate the increase of the second magnetic moment of poly(methylmethacrylate) with elongation of the sample. TAB

N67-19876*# Shell Development Co., Emeryville, Calif.
DEVELOPMENT OF HYDROGEN-OXYGEN CATALYSTS Final Report, Aug. 1965–Jul. 1966
T. J. Jennings, W. E. Armstrong, and H. H. Voge Jul. 67 p refs
(Contract NAS7-387)
(NASA-CR-72118) CFSTI: HC $3.00/MF $0.65 CSCL 07B

This report presents results of a program designed to develop catalysts of improved activity and thermal stability for catalytic ignition of an oxygen-hydrogen mixture at low temperatures. A rising temperature testing technique was developed to determine the activity of many catalysts at temperatures down to that of liquid nitrogen (−195°C, −320°F). Several formulations showed improved activity over catalysts prevously available. Of these, the Shell 405 type catalyst developed under a classified government contract for the decomposition of hydrazine was the most active. It caused reaction of the dilute hydrogen-oxygen test mixture to occur at −195°C when tested in both the "as prepared" state and after exposure to a hydrogen-steam atmosphere at 1100°C (2012°F) for 30 minutes, the Shell 405 catalyst was somewhat deactivated, and, like several other catalysts, gave reaction at about −140°C (−220°F). Of the others, Pt–Ru on "super-pure" alumina and Pt-Ru on zirconia-thoria were the more active. Author

N67-19943*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
FERROCENE AND FERROCENE DERIVATIVES

William P. McNutt and Charles V. Pittman, Jr., 30 Sep. 1966 430 p refs Jointly supported by Army Missile Command
(NASA-TM-X-59478; RSIC-591) CFSTI: HC $3.00/MF $0.65 CSCL 07C

This is an annotated bibliography covering ferrocene and its derivatives from 1962 to August 1966. Several review articles are listed which describe the unique characteristics of ferrocene since its discovery in 1951, its reactions, and some of its uses. Approximately 550 citations are listed. Author

N67-19981*# Pennsylvania Univ., Philadelphia. Electrochemistry Lab.
STUDIES IN FUNDAMENTAL CHEMISTRY OF FUEL CELL REACTIONS Semiannual Progress Report, 1 Jul.–31 Dec. 1966
John O'M. Bockris 3 Dec. 1966 63 p refs
(Grant NsG-325)
(NASA-CR-82978; Rept.-9) CFSTI: HC $3.00/MF $0.65 CSCL 07D

Various studies in the chemistry of fuel cell reactions are reviewed. The effect of electrode materials on simple electrochemical reactions was investigated, as well as the mechanism of porous electrodes. Measurements of potentials of zero charge on platinum were continued to determine whether platinum electrodes were free of hydrogen. Concentration variation in alkaline solutions for capacitance on platinum is studied, and potential of zero charge values are reported for silver and nickel. The effect of varying electrolyte concentration on capacitance of platinum electrodes in alkaline solutions was studied. Measurements on benzene adsorption on platinized platinum were carried out by means of potential sweep (potentiodynamic) and galvanostatic methods and comparison between these two methods and the radiotracer method was made. Mention is made of studies pertaining to electrode kinetic aspects of energy conversion, theory of charge transfer, and an introduction to electrochemistry. S.P.

N67-20191# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
APPLICATIONS OF NUCLEAR MAGNETIC RESONANCE SPECTRA IN THEORETICAL ORGANIC CHEMISTRY RESEARCH
Chia-Lai Pan 13 Oct. 1966 27 p refs Transl. into ENGLISH from Hua-Hsueh Tung-Pao (Peiping), no. 7, 1965 p 11–17
(FTD-HT-66-423; TT-67-60238; AD-643898) CFSTI: HC $3.00/MF $0.65

Topics include: Relationship between molecular structure and magnetism; The study of the nature of bonds by the use of the nuclear magnetic parameters (Determination of ionic character, The influence of hybridization); Nuclear magnetic shielding and effects of radical groups. TAB

N67-20203# Hunter Coll., New York
DIVINYLBENZENE BIBLIOGRAPHY Interim Report
Richard H. Wiley 3 Nov. 1966 96 p refs
(Contract AT(30-1)-3644)
(NYO-3644-10) CFSTI: HC $3.00/MF $0.65

One thousand one hundred and nineteen references on divinylbenzene are presented. They were collected from Beilstein and Chemical Abstracts through volume 62. NSA

N67-20207# Reactor Group, United Kingdom Atomic Energy Authority, Sellafield (England). Production Group.
APPLICATIONS OF ABSORPTION SPECTROPHOTOMETRY (INFRARED AND VISIBLE) TO THE DETERMINATION OF IMPURITIES IN TRIBUTYL PHOSPHATE AND DEGRADED TRIBUTYL PHOSPHATE/KEROSENE MIXTURES
E. Hughes 1966 18 p refs
(PG-737) HMSO: 2s 6d

A review is presented of the development of a number of methods for the analysis of raw tributyl phosphate and degraded process solvents. The work is based on absorption spectrometric techniques in the infrared and visible regions, with or without preliminary chemical separation. Each of these methods was applied for a number of years to the routine analysis of process solvent and samples arising from various research projects. The methods enabled quantitative studies of the effect of solvent degradation on process performance to be made. Author (NSA)

N67-20208# California Univ., Berkeley. Lawrence Radiation Lab.
GASEOUS THERMAL ELECTRON REACTIONS
Charles E. Young (Ph.D. Thesis) Sep. 1966 98 p refs
(Contract W-7405-ENG-48)
(UCRL-17171) CFSTI: HC $3.00/MF $0.65

A microwave cavity resonance technique was used to study the rate of disappearance of gaseous electrons in the presence of molecules which can capture them to form negative ions. Electron concentrations of 10^7 and 10^8 per cc were produced by photoionization of a small amount of NO with a single pulse of 1216 or 1236 Å light from microwave discharge in hydrogen or krypton, respectively. Experimental conditions also involved the presence of 1 to 100 torr of inert gas, which permitted the electrons to reach quickly a Maxwellian energy distribution corresponding to 300°K, and reduced the diffusional loss of electrons. Under these conditions, electron attachment of SF_6, C_7F_{14}, and C_3F_8 was observed to correspond to a two body process with rate constants of 2.7×10^{-7}, 8.8×10^{-8}, and 8.8×10^{-12} cc/molecule-sec, respectively. Attachment to C_2F_4 and SiF_4 appeared to be a three body process but estimation of rate constants was less accurate. The effectiveness of various inert gas molecules in producing three body attachment of electrons to NO was also investigated. For He, Ne, N_2, Ar, Kr, and Xe, measured three body rate constants were, respectively, 2.2×10^{-32}, 1.8×10^{-32}, 3.7×10^{-32}, 3.2×10^{-32}, 0.65×10^{-32}, and 10.3×10^{-32} $(cc/molecule)^2sec^{-1}$. Author (NSA)

N67-20213# United Kingdom Atomic Energy Authority, Springfields (England). Production Group.
A POTENTIOMETRIC, HIGH PRECISION, ASSAY METHOD FOR THE DETERMINATION OF URANIUM METAL
1966 14 p
(PG-720) HMSO: 2s 6d

A portion of the sample is dissolved in orthophosphoric acid. Lower valency states of impurities and U^{3+} are oxidized by aeration and an excess of potassium dichromate over that required to oxidize the tetravalent uranium is added. The excess potassium dichromate is then titrated potentiometrically using ferrous ammonium sulfate solution. For uranium metal of 99.98% purity the bias does not exceed ±0.005%. The standard deviation at the 99.98% level is ±0.0045%. Author (NSA)

N67-20214# Mallinckrodt Chemical Works, Weldon Spring, Mo. Uranium Div.
PHASE STUDIES OF THE URANIUM–IRON–ALUMINUM TERNARY SYSTEM WITH THE ELECTRON MICROPROBE
R. G. Schierding and L. A. Fergason 1 Aug. 1966 20 p refs
(Contract W-14-108-ENG-8)
(MCW-1503) CFSTI: HC $3.00/MF $0.65

The solubility limits of Fe and Al in the U allotropes and in the intermetallic phases U_6Fe and UAl_2 were determined by electron microprobe analysis. The U-rich portion of the U–Al phase diagram was presented along with isothermal sections of the U-rich corner of the U–Fe–Al ternary system. Author (NSA)

N67-20215# Mallinckrodt Chemical Works, Weldon Spring, Mo. Uranium Div.

LABORATORY DEVELOPMENT OF THE URANIUM ELECTROREDUCTION PROCESS

R. D. Piper 1 Jul. 1966 38 p refs
(Contract W-14-108-ENG-8)
(MCW-1500) CFSTI: HC $3.00/MF $0.65

A laboratory process for electroreduction of uranium oxides to uranium metal was carried out in a molten fluoride-salt electrolyte at temperatures above 1130°C. An all-liquid approach gave up to 44% current efficiency and very flexible operation, and a frozen-crust approach gave 80% current efficiency but was more limited in operation. Author (NSA)

N67-20257* Air Reduction Co., Inc., Murray Hill, N. J. Research and Engineering Dept.

INVESTIGATION OF REACTIVITY OF TITANIUM AND OTHER MATERIALS WITH LIQUID OXYGEN AND NITROGEN TETROXIDE Final Report, 22 May 1965–21 May 1966

R. Newcombe 9 Nov. 1966 131 p refs With Supplement
(Contract NAS8-20078)
(NASA-CR-82849; RE-66-111-CRE-35; RE-66-111-CRE-35, Suppl. 1) CFSTI: HC $3.00 CSCL 07B

Summarized is the development and application of equipment and methods for determination of the energy required to initiate reaction of oxygen or nitrogen tetroxide with various engineering materials by one mode of energy input, namely adiabatic compression. Design, fabrication, and evaluation studies are presented for a piston type adiabatic compressor apparatus with the capabilities of operating in a temperature range from −183.0°C (−297.4°F) to 150°C (302°F) and attaining a maximum pressure of 30,000 p.s.i. within the sample chamber. An experimental test and data evaluation program is described, which was limited due to the emphasis placed on attaining the required testing parameters and damaging effects to the tester when reactions occurred between an oxidizer and the material under test. A recommendation is presented which would limit the damaging effects of a reaction to expendable parts. Author

N67-20307# Kernforschungsanlage, Juelich (West Germany). Zentralbibliothek.

THE PHYSICAL AND PHYSICOCHEMICAL PROPERTIES OF KRYPTON, A BIBLIOGRAPHY [KRYPTON PHYSIKALISCHE UND PHYSIKALISCH-CHEMISCHE EIGENSCHAFTEN, EINE LITERATURZUSAMMENSTELLUNG]

E. Paul and G. Gehrke Sep. 1966 22 p refs In GERMAN
(JUL-BIBL-11) CFSTI: HC $3.00/MF $0.65

A 209-title bibliography covering the period from 1940 through 1966 is presented. The following sources were used: *Chemical Abstracts, Chemisches Zentralblatt, Nuclear Science Abstracts, Physics Abstracts,* and *Physikalische Berichte.* Transl. by K.W.

N67-20309 Gt. Brit. Ministry of Aviation, London. Technical Information and Library Services.

THE THERMAL DECOMPOSITION OF AMMONIUM PERCHLORATE

H. Osada and E. Sakamoto Nov. 1966 12 p refs Transl. into ENGLISH from Kogyo Kayaku Kyokaishi (Tokyo), v. 24, no. 5, 1963 p 236–244
(TIL/T-5597) CFSTI: HC $3.00

The effect of particle size, ambient atmosphere, additives and irradiation of samples by X-rays and uv radiation on the thermal decomposition of ammonium perchlorate were studied. Rate of decomposition equations indicated that the reaction was first order at low temperature and 1/2 order at high temperature. Acid analysis indicated $HClO_4$ as a product. Gaseous product analyses also made, metallic chlorides, chromic oxide, potassium chromate and potassium bichromate, as added impurities, accelerate the decomposition of the perchlorate. The ignition of ammonium perchlorate was briefly examined. Author

N67-20325# Kernforschungsanlage, Julelich. (West Germany). Inst. fuer Physikalische Chemie.

ISOTOPE EFFECTS BY ION-EXCHANGE SEPARATION OF RARE EARTHS [ISOTOPIE-EFFEKTE BEI IONENAUSTAUSCH-ERTRENNUNGEN VON SELTENEN ERDEN]

H. Ihle H. Michael Aug. 1966 22 p refs In GERMAN; ENGLISH summary
(JUL-402-PC) CFSTI: HC $3.00/MF $0.65

The isotope effects which occur during the separation of rare earths on ion exchange columns were measured. The investigation was carried out by partition of Sm^{3+} between Dowex 50W cation-exchange resin, and aqueous solutions of α-hydroxy-iso-butyrate and tartronate as complexing agents. The separation factor for the two samarium isotopes, differing by one mass unit, was: $K=1+3\times10^{-5}$. In agreement with the theory, the lighter isotope was enriched on the resin. As expected, the measured effect is smaller than the maximum value calculated from theoretical considerations under idealized conditions. Author

N67-20334 Royal Aircraft Establishment, Farnborough (England).

SOME EXPERIMENTS ON THE CURE OF AN UNSATURATED POLYESTER SYSTEM. PART II: MEASUREMENT OF VOLUME RESISTIVITY, BARCOL HARDNESS AND ACETONE EXTRACTION IN THE ADVANCED STAGES OF THE CURING REACTION

N. C. W. Judd Aug. 1966 22 p refs
(RAE-TR-66261) CFSTI: HC $3.00

Volume resistivity, Barcol hardness and acetone extraction measurements have been made on cast polyester specimens in the advanced stages of the curing reaction. The results show that the acetone extraction technique is the most sensitive for assessing the extent of cure. Measurement of volume resistivity changes during the curing reaction with continuous and with intermittent voltages gave different results. When glass cloth was used as a filler the composite had a resistivity lower than that of the cast resin. An analysis of the results together with other data reported in the literature illustrates and difficulties in correlating the results for extent of cure as measured by volume resistivity, Barcol hardness and acetone extract. Author

N67-20337# Royal Aircraft Establishment, Farnborough (England).

CALCULATION OF THE GLASS TEMPERATURES OF POLYMERS HAVING ALKYL SIDE-CHAINS

W. A. Lee and Diana O'Mahony Sep. 1966 26 p refs
(RAE-TR-66292) CFSTI: HC $3.00/MF $0.65

Four equations, relating the glass temperatures (T_G's) of polymers to invariant temperature parameters associated with their constituent groups, but weighted in different ways, have been applied to the calculation of the T_G's of 7 series of polymers having alkyl side-chains. It is shown that the T_G's of the 32 polymers considered may be expressed as the sum of the mole fractions of the parameters within maximum and mean errors of 11 and 4°K respectively. The temperature parameter for a sequence of three, or more, methylene groups is correctly estimated as 153°K. Nearest neighbour interactions, stereoregularity, and crystallinity effects are discussed. Author

N67-20338# European Atomic Energy Community, Brussels (Belgium).
THERMODYNAMIC STUDY ON URANIUM TRICHLORIDE DISSOLVED IN MOLTEN ALKALINE CHLORIDES [ETUDE THERMODYNAMIQUE SUR LE TRICHLORURE D'URANIUM DISSOUS DANS LES CHLORURES ALCALINS FONDUS]
C. Hardy-Grena Oct. 1966 27 p refs In FRENCH
(EUR-3153.f) CFSTI: HC $3.00/MF $0.65

The thermodynamic properties of dilute solutions of UCl_3 in NaCl are studied in the temperature range 730°C to 850°C. In this view, the partial vapor pressure of NaCl above the solution was measured by the Knudsen method and the activity coefficients of NaCl and UCl_3 calculated. The dilute solutions of UCl_3 in NaCl do not behave ideally; UCl_3 exhibits positive deviations from Raoult's law in NaCl. This fact would point out the formation of complex anions in the melts. Author

N67-20353# Royal Aircraft Establishment, Farnborough (England).
IONIZATION AND DISSOCIATION OF SOME AROMATIC IMIDES UNDER ELECTRON-IMPACT
J. L. Cotter and R. A. Dine-Hart Aug. 1966 14 p refs
(RAE-TR-66254) CFSTI: HC $3.00/MF $0.65

The mass spectra of phthalanil, N-phenyl-1:8-naphthalimide, 4-phthalimido-biphenyl, and 2-phthalimidobiphenyl are recorded and discussed. These compounds give abundant molecular ions, and, with the exception of the last compound, give rise to intense $M-CO_2$ peaks. The ionization potentials of these compounds are reported. Author

N67-20354# Royal Aircraft Establishment, Farnborough (England).
THERMAL DEGRADATION STUDIES ON OXADIAZOLES
J. L. Cotter, G. J. Knight, and W. W. Wright Oct. 1966 13 p refs
(RAE-TR-66331) CFSTI: HC $3.00/MF $0.65

2,5-diphenyl-1,3,4-oxadiazole and 3,5-diphenyl-1,2,4-oxadiazole were pyrolysed in sealed ampoules and the volatile degradation products examined either by gas liquid chromatography or by mass spectrometry. Good agreement was obtained between the two analytical techniques. Despite a considerable difference in the thermal stability of the two compounds, the major breakdown products (benzonitrile and phenyl isocyanate) were the same in both cases. The phenyl isocyanate further reacted to a certain extent to give diphenylcarbodiimide and carbon dioxide. As the 1,3,4-oxadiazole structure was the more thermally stable, poly(phenylene-1,3,4-oxadiazole) was prepared and its degradation studied by the sealed ampoule method and also by flash pyrolysis using either the tungsten filament technique, or that involving introduction of a small boat containing polymer into a previously heated furnace. Results obtained for the polymer by the three methods are compared and contrasted and the mechanism of decomposition compared with that of the model compounds. Author

N67-20355 Gt. Brit. Ministry of Aviation, London.
FULLY-AUTOMATIC APPARATUS FOR THE SIMULTANEOUS DETERMINATION OF CARBON, HYDROGEN AND NITROGEN IN ORGANIC COMPOUNDS IN MILLIGRAMS AND SUBMILLIGRAM QUANTITIES BY THE APPLICATION OF A SELF-INTEGRATING THERMAL CONDUCTIVITY MEASURING METHOD [VOLLAUTOMATISCHE ANALAGE ZUR GLEICHZEITIGEN BESTIMMUNG VON KOHLENSTOFF, WASSERSTOFF UND STICK-STOFF IN ORGANISCHEN VERBINDUNGEN AND MILLIGRAM UND SUB-MILLIGRAMMENGEN UNTER VERWENDUNG EINER SELBSTINTEGRIERENDEN WARMELEITFAHIGKEITSMESSMETHODIK]
J. T. Clerc, R. Dohner, W. Sauter, and W. Simon Jan. 1967 26 p refs Transl. into ENGLISH from Helv. Chim. Acta (Basel), v. 46, no. 6, 1963 p 2369–2388
(TIL/T-5689) CFSTI: $3.00

An analyser for the simultaneous determination of carbon, hydrogen, and nitrogen in organic compounds is described. The samples are burned in a static system in oxygen and the combustion products are determined using a self-integrating thermal conductivity method. Up to 16 previously weighed samples of 0.5–2.0 mg are analysed without any manual help and the results are presented in digital form. One determination takes between 7 and 13 minutes. At present the standard error of a single determination is 0.20, 0.8, and 0.30% (absolute) for carbon, hydrogen, and nitrogen, respectively; but these figures may easily be improved by minor modifications. Author

N67-20366# Kernforschungsanlage, Juelich (West Germany). Institut fuer Physikalische Chemie.
THE COUNTING OF Pm-147 USING LIQUID SCINTILLATION DETECTORS EMPLOYING THE CHANNEL-RATIO METHOD FOR THE CORRECTION OF QUENCHING EFFECTS [DIE ZAEHLUNG VON PM-147 MIT HILFE EINES FLUESSIG-SZINTILLATIONSDETEKTORS UNTER ANWENDUNG DER KANALVERHAELTNISMETHODE ZUR KORREKTUR VON LOESCHEFFEKTEN]
A. F. Blair and A. P. Murrenhoff Apr. 1966 23 p refs In GERMAN; ENGLISH summary
(JUL-377-PC) CFSTI: HC $3.00/MF $0.65

A method for the stabilization of liquid scintillation solutions by addition of tri-n-octylphosphinoxide, which had originally been developed for solutions containing actinide elements, has been successfully applied to the counting of Pm-147 samples containing a high concentration of nonactive salts and nonvolatile organic substances. The channel-ratio method was used for the correction of quenching effects. The correction curves for the quenching effects due to water, nitric acid, lithium nitrate, trilaurylamine, and tri-n-octylphosphinoxide proved to be identical within 1 to 2%. Experiments to investigate the stability of the counting results with time gave values constant to within better than 1% over a period of 30 days, when up to 1 volume % of 7 n HNO_3 was added to the scintillator solution. Author

N67-20371# Sussex Univ., Brighton (England).
THERMAL STABILITY OF SOME METALLOSILOXANES
J. A. Bedford and G. E. Le Grow London, Min. of Aviation, Sep. 1966 22 p refs
(ZB/106/04; Rept.-140) CFSTI: HC $3.00/MF $0.65

In order to study the thermal stability of metallosiloxane systems, the following compounds were prepared in a pure state and their behavior on heating in absence of air examined: $(Me_3SiO)_nM$, where M = Si(n = 4), Ge(n = 4), Sn(n = 4), Ti(n = 4), and Al(n = 3); $(Et_3SiO)_3Al$ and $(Et_3SiO)_4Ti$; and $(Ph_3SiO)_4Sn$, $(Ph_3SiO)_4Ti$, and $(PhSiO)_3Al$. Previous work is outlined, and details are given on the preparation of metallosiloxanes, analysis of decomposition products, thermal decomposition, and hydrolysis of $(Me_3SiO)_nM$ compounds. It was concluded that introduction of M–O–Si linkages into polysiloxanes is not likely to lead to an increase in thermal stability. In liquid polymers, except when M = Ge, it will lead to a marked fall in stability; however, in solid systems the thermal stability could be acceptable if other properties were present. The marked hydrolytic instability of the M–O–Si linkages, except when M = Ge, will place a severe limitation on the usefulness of polymers containing them. L.E.W.

N67-20377*# Georgia Inst. of Tech., Atlanta. School of Chemical Engineering.
CHEMICAL REACTIVITY OF HYDROGEN, NITROGEN AND OXYGEN ATOMS AT TEMPERATURES BELOW 100°K Semiannual Report, 1 Jul.–31 Dec. 1966
James A. Knight, Jr. Jan. 1967 23 p refs
(Grant NsG-337)
(NASA-CR-82983; SAR-2) CFSTI: HC $3.00/MF $0.65 CSCL 07C

Research aimed at attaining chemical information at cryogenic temperatures, particularly on systems important in comets and in the atmospheric and surface chemistry of the Jovian planets, is reviewed. Since evidence suggests that the activation energy for the reaction of low molecular weight free radicals is zero (or close to it), the approach used is to prepare these species in stable forms by diffusional inhibition techniques such as inert matrix isolation. The approach used is discussed, and the equipment is described. Research in the following areas is summarized: cyclobutadiene (synthesis, metal atom spectra in comets, and low temperature charge transfer complexes as a source of color of planetary disks), oxirene, cyclopropanone, and other species. L.E.W.

07 COMMUNICATIONS

Includes communications equipment and techniques; noise; radio and communications blackout; modulation telemetry; tracking radar and optical observation; and wave propagation. For basic research see: 23 Physics, General; and 21 Navigation.

N67-19458# Lowell Technological Inst. Research Foundation, Mass.
SATELLITE-TO-SATELLITE EXPERIMENT Final Report, 1 Jan.–31 Dec. 1965
Joseph A. Patenaude and Bodo W. Reinisch Nov. 1966 50 p ref
(Contract AF 19(628)-4957)
(LTIRF-253/IP; AFCRL-66-502; AD-644823) CFSTI: HC $3.00/MF $0.65

A ground station integrated in a satellite-to-satellite radio propagation experiment has been set up in Bedford, Mass. Pulse and cw transmissions from the daughter satellite on 6.8 MHz, 13.6 MHz, and 136 MHz were to be received directly during satellite passes. Stored data of radio propagation between the separating daughter and the relaying mother satellite were to be recorded over two telemetry channels. Equipment for investigation of pulse amplitude and shape as well as dispersive Doppler frequency shift and Faraday rotation was built. New techniques for Doppler and Faraday observations using turnstile antennas, linear phase detectors, and special receiver configurations have been incorporated. The method of recording and processing the high-frequency information and the telemetry data is outlined. Author (TAB)

N67-19545# New York Univ., N. Y. Lab. for Electroscience Research.
QUEUEING AND INTERFERENCE AMONG MESSAGES IN A COMMUNICATION SYSTEM WITH TRANSMISSION DELAY Interim Scientific Report
Paul T. Brady Jun. 1966 113 p refs
(Grants AF-AFOSR-24-66; AF-AFOSR-24-65)
(TR-400-134; AFOSR-66-2049; AD-640403) CFSTI: HC $3.00/MF $0.65

This thesis describes a technique for analyzing the statistical behavior of a two-way communication system with transmission delay (D). The transmit/receive devices, or servers, at the terminals are constructed so that they cannot transmit and receive simultaneously. Each server is therefore designed not to interrupt reception of a message with its own transmission. If D > 0, each server is uncertain of the present state of the other, and may initiate transmission when the other has already begun to transmit, thus causing message interference. Interference is measured as the amount of one servers transmission which arrives at the other server when it is already transmitting. The relationship between the size of the delay and the amount of interference is studied here, as well as other quantities that describe the system behavior. The exact solution is available only for D = 0, but an approximate solution is found for D very small with respect to the lengths of idle periods of the servers, and the asymptotic solution is obtainable for D very long. Good agreement is found between theoretical results and those obtained from simulation. Theoretical results have been obtained for a variety of systems fitting the two-way communication model proposed here, but there are certain important cases for which the only results yet available are from simulation. Author (TAB)

N67-19570# Mitre Corp., Bedford, Mass.
DESIGN PROBLEMS IN VISUAL DISPLAYS. PART II: FACTORS IN THE LEGIBILITY OF TELEVISED DISPLAYS
Donald A. Shurtleff Sep. 1966 72 p refs
(Contract AF 19(628)-5165)
(MTR-203; ESD-TR-66-299; AD-640571)

The literature on the legibility of numerals, capital letters, and words on television displays, dating from the late 1940s to the present, is evaluated. Selected studies of such factors as vertical resolution, video bandwidth, and direction of scanning are reviewed in detail. Conclusions are drawn, and recommendations are made for display design and applications. Author (TAB)

N67-19572# Michigan Univ., Ann Arbor. Inst. of Science and Technology.
THE EFFECTS OF DISPERSION IN LINEAR ARRAYS
C. B. Sharpe and R. B. Crane Oct. 1966 18 p ref
(Contract DA-28-043-AMC-00013(E); Proj. Michigan)
(Rept.-6400-87-R; ECOM-00013-87; AD-640752) CFSTI: HC $3.00/MF $0.65

The effects of waveguide dispersion on the radiation pattern and directivity of series-fed, linear arrays are investigated, and an expression for the directive gain of such arrays is derived. The directivity and radiation patterns for typical arrays are presented for various values of signal bandwidths and waveguide cutoff frequencies. It is shown that the detrimental effects of dispersion on both directivity and beamwidth are substantial when the signal bandwidth is comparable to the nominal bandwidth of the array. Author (TAB)

N67-19612# Stanford Univ., Calif. Computer Science Dept.
AN APPROACH TO COMPUTER SPEECH RECOGNITION BY DIRECT ANALYSIS OF THE SPEECH WAVE
D. R. Reddy 1 Sep. 1966 14 p refs
(Contract ARPA SD-183)
(C-49; AI-Memo-43; AD-640836) CFSTI: HC $3.00/MF $0.65

CONTENTS: Speech analysis; Design of a man-machine communication system for speech research; Segmentation, pitch detection and parameter determination; Classification of speech sounds; Results; Conclusions. TAB

N67-19614# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.
ELECTROMAGNETIC DOPPLER SHIFT DATA FOR SATELLITES IN CIRCULAR POLAR ORBITS AT ALTITUDES BETWEEN 250 AND 1000 NAUTICAL MILES
Gary N. Natuck and John F. Clark Aug. 1966 274 p refs
(Contract NOw-62-0604-c)
(TG-849; AD-640606) CFSTI: HC$3.00/MF$0.65

A computer program has been used to generate doppler shift of an electromagnetic signal from an orbiting satellite as a function of time. The predicted doppler shift as a function of time is available in two different output formats: a continuous plot of doppler as a function of time before and after closest approach and a tabulated list of doppler as a function of time. The computer program employs a spherical earth and a circular, polar orbit for the satellite. Author (TAB)

N67-19661# Sydney Univ. (Australia). Falkiner Nuclear Dept.
A NEW METHOD OF RECORDING LARGE COSMIC RAY AIR SHOWERS
C. B. A. Mc Cusker and M. M. Winn [1962] 10 p refs
(Grant AF-AFOSR-62-410)
(AD-640871) CFSTI: HC$3.00/MF$0.65

The difficulty of recording fast timing information in a large air shower array is discussed and a possible solution to this problem is proposed. The time of passage of shower fronts at each detector station in the array is to be measured with respect to the time as given by a time signal transmitter in or near the array. Details of the method are given. Author (TAB)

N67-19678# Resources Development Inst., Huntington Station, N. Y.
MATCHED INDUCTIVE PLATE RADOME Final Technical Report, Mar. 1–Aug. 31, 1966
Edward B. McMillan 24 Oct. 1966 29 p refs
(Contract N00014-66-C0156)
(Rept.-624101; AD-641355) CFSTI: HC$3.00/MF$0.65

The objective was to find for radome design engineers an electrical approach which would permit more adequate environmental design for the microwave and especially the millimeter regions. To escape the structural dependence upon the thickness requirement of the customary phase delay design, phase advance possibilities were examined. This led to a study of the perforation of a structural metal plate for phase advance properties and sandwiching it between protective dielectric phase delay layers. The characteristics of an inductive two-dimensional lattice of very small circular holes were studied and selected as the most promising. It was concluded that while improved environmental adequacy would be inherent, workable design techniques could not be made ready until susceptance theory for holes in lattices was amplified, put in engineering form and test data reconciled with it. Author (TAB)

N67-19685# Rome Air Development Center, Griffiss AFB, N. Y.
ON A DEFINITION OF BANDWIDTH
Jack K. Wolf Nov. 1966 29 p refs
(RADC-TR-66-521; AD-643560) CFSTI: HC$3.00/MF$0.65

Various definitions of bandwidth are examined for non-bandlimited random processes. Properties and shortcomings of these definitions are discussed. The bandwidths of several random processes are calculated and in most instances, the different definitions yield different answers. The bandwidth of an amplitude and/or angle modulated wave is calculated using one definition and the results compared to those found by Abramson who used a different definition. Author (TAB)

N67-19689# Harvard Univ., Cambridge, Mass. Cruft Lab.
ON THE ELECTRICALLY THICK CYLINDRICAL ANTENNA
David C. Chang Aug. 1966 56 p refs
(Contract Nonr-1866(32))
(TR-509; AD-643227) CFSTI: HC$3.00/MF$0.65

The problem of a thick cylindrical antenna driven by a delta-function generator is investigated. Numerical solutions are obtained for two different mathematical models - one is driven by a delta-function generator on both outside and inside surfaces of the antenna, and another is driven only on the outside surface. In both cases, current singularity near the driven point has been taken care of and subsequently subtracted out, before the numerical solution is applied. For antennas with circumferences less than a free-space wavelength, the results are compared with the experimental data obtained by Holly. For antennas with larger radii, no experimental data are yet available. Author (TAB)

N67-19723# Naval Research Lab., Washington, D. C.
CONJUGATE-PAIR FEED SYSTEMS Interim Report
Max L. Reuss, Jr. 29 Sep. 1966 10 p
(NRL-6425; AD-642283) CFSTI: HC$3.00/MF$0.65

Two microwave feed circuits have been developed for use in electronically scanned antenna arrays. Both of these circuits offer advantages over the conventional circuits employing nonreciprocal phase shifters of the digital type. The first circuit permits reduction in the number of phase shifters by requiring one phase shifter for each pair of radiating elements rather than the usual phase shifter per radiating element, while the second circuit permits simultaneous reception and transmission of signals with independent control of the transmit and receive beam directions. An X-band model was constructed, and radiation patterns were obtained from a seven-element array fed by these circuits. The results demonstrate the feasibility of both circuits. TAB

N67-19724# TRW Systems, Redondo Beach, Calif.
FUNCTIONAL SPECIFICATIONS OF LINCOLN LABORATORY ORBIT DETERMINATION PROGRAMS
10 May 1966 515 refs Prepared for MIT, Lincoln Lab.
(Contract AF 19(628)-5167)
(ESD-TR-66-248; AD-643376) CFSTI: HC$3.00/MF$0.65

The report describes the orbit determination programs and data processing programs developed by TRW Systems for the Lincoln Laboratory Millstone Hill radar. These programs provide the SDS 9300 computer associated with the radar with the following capabilities: satellite orbit prediction, antenna steering, data and editing averaging, and differential correction of the orbit elements. The programs that support the radar during a tracking operation are fully automatic, under the control of the radar hardware and the operators console. They perform sufficiently fast to permit their use during a radar tracking pass and, thereby, provide real time orbit determination capabilities in supporting the tracker. This facility is accomplished by partitioning the orbit determination functions into those which can be performed before the pass, after the pass, and doing only the absolute minimum processing during the pass. The capabilities in the real time programs (MHESPOD) have also been provided in a stand-alone support program for nonreal time use (NRTPOD). Author (TAB)

N67-19740# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.
A SIMPLIFIED TRACKING FILTER FOR SATELLITE SYSTEMS TESTING
Leigh R. Sanford Jun. 1966 50 p
(Contract NOw-62-0604-c)
(TG-829; AD-642617) CFSTI: HC$3.00/MF$0.65

The report describes an extreme simplification of a commercial phase lock tracking filter to be used for in-house testing of satellite systems. Stability and long term drift is almost as good in the simplified model as the Electrac 215A, but the signal-to-noise performance is somewhat degraded. A bad signal-to-noise ratio should not be encountered in satellite systems testing. Phase modulation outputs and correlation outputs are provided. The system has a tracking range of 30 kilocycles, a data bandwidth of 8 kilocycles, and a tracking loop bandwidth of 10 cycles. The input center frequency is 70 kilocycles. The system is packaged on three printed circuit cards. These cards plug into a frame containing power supplies and audio amplifiers. A complete parts list is included at the end of the report. Author (TAB)

N67-19743# Naval Submarine Medical Center, Groton, Conn. Submarine Medical Research Lab.

VOICE COMMUNICATION PROBLEMS IN SPACECRAFT AND UNDERWATER CONDITIONS Interim Report

Russell L. Sergeant 10 Nov. 1966 28 p refs Presented at the Conf. on Sound Production in Man, New York, 9 Nov. 1966

(Rept.-485; AD-642825) CFSTI: HC $3.00/MF $0.65

Various problems in voice communication systems found in operations underwater and in outer space are considered. Since the production of speech is basic to these problems, the major part of the article is devoted to factors affecting vocal production. Examples are given of special problems which arise when the voice communication situation involves highly restrictive environmental factors such as those encountered by deep sea divers, swimmers, and personnel within under-the-sea habitats or space capsules. In addition to the effects on speech of varying ambient pressures, changes to the voice caused by different gas mixtures are described. Several ways of making helium-speech more intelligible are presented. Problems with the electronic link between the talker and listener are discussed. It is pointed out that the effectiveness of communication systems can be increased by proper circuit discipline, training to speak clearly, and utilization of vocabularies specific to the immediate operation. The need for improved coordination among behavioral and engineering efforts to solve problems of communication in space and underwater environments is emphasized. Author (TAB)

N67-19810# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

ANTENNA MEASUREMENTS AT SUPER-HIGH FREQUENCIES (ANTENNA PRACTICAL WORK)

Yu. V. Shubarin and A. F. Zorkin 5 Oct. 1966 167 p refs Transl. into ENGLISH of the Book "Antennyye Izmareniya Na Sverkhbysokikh Chastotakh" Kharkov, 1962 p 1–70

(FTD-MT-65-394; TT-67-60345; AD-644569) CFSTI: HC $3.00/MF $0.65

In the first chapter there is given a basis and account of the method of measurement of basic parameters of shf antennas, typical circuits applied here and also methods of processing and estimating error of measurements. In the second chapter seven laboratory projects of antenna practical work are described. The practical work permits us to subject to graphic experimental proof a series of very important theoretical propositions expounded in the course on shf antennas; to illustrate the method of measurements of parameters of antennas with practical examples; to acquaint students with the design and certain methods of engineering calculation of basic types of shf antennas. Description of every practical project contains information on designing the proper laboratory installation, assignment for conducting experiments and calculations, and also a list of materials which should be presented in the report on the finished project. Selection of problems for practical work and the character of assignments are aimed at development in students of a desire for independent investigation. Everywhere where possible, comparison of theory with experiment and estimation of its accuracy are required. In the third chapter there is given a description of a series of samples of typical equipment applied during shf antenna measurements. This facilitates home preparation of students for doing assignments of antenna practical work and can serve as a brief reference book on frequently used equipment. Author (TAB)

N67-19822# Army Test and Evaluation Command, White Sands Missile Range, N. Mex.

GENERAL DISCUSSION OF GEOMETRICAL FACTORS AFFECTING TRILATERATION SOLUTIONS FOR POSITION AND VELOCITY

Ernest S. Alvarez Mar. 1966 93 p refs

(RISO-3-66; AD-644633)

The study presents an analysis of the influence of geometrical factors upon trilateration solutions. The results are in a form which find general application to many station configurations and target trajectories. A discussion of velocity variances is presented in sufficient detail to demonstrate the interdependence of station configuration and target dynamics. This discussion yields useful criteria for use in the design of a range and range-rate measuring system. The study also includes an analysis of single-station solutions for comparison purposes. Author (TAB)

N67-19838# Frankford Arsenal, Philadelphia, Pa.

ATMOSPHERIC ATTENUATION MEASUREMENTS AT 600 GHz

Shurman Y. Chang and James D. Lester Aug. 1966 27 p refs

(M67-4-1; AD-644587) CFSTI: HC $3.00/MF $0.65

Atmospheric absorption in the 600 GHz region has been measured throughout the actual atmosphere by means of a Dicke type superheterodyne radiometer receiver using second harmonic mixing. The average measured value of horizontal attenuation was approximately 34 db/km/g/cu m. The variation of water vapor absorption with respect to water vapor density was also indicated in the measured results. The minimum detectable temperature difference (delta T) min was obtained by calculating the rms value of output deflection and the use of the calibration curve for the radiometer. The best value achieved was 5.2K. From this result, the radiometer receiver noise figure and the mixer conversion loss were able to be determined indirectly. The results were 33.2 db and 26.4 db respectively. Author (TAB)

N67-19839# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

METHOD OF SELECTING MOVING RADAR TARGETS

N. K. Ignat'yev 27 Jun. 1966 5 p Transl. into ENGLISH from Russian Patent no. 150140 (Appl. no. 420483/26, 23 Aug. 1949) 2 p

(FTD-HT-66-79; AD-643712)

The object of the invention is a method of selecting moving radar targets with the recording of reflected signals which has distinguishing feature that for the purpose of comparing signals with subsequent reflected signals there are used three continuous alternating cycles of operation - the cycle of recording the signals in positive polarity, the cycle of recording the signals in negative polarity, and the cycle of reproduction of the recordings in the two preceding cycles. Author (TAB)

N67-19840# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.

DEGRADATION OF A PULSE COMPRESSION SYSTEM DUE TO RANDOM PHASE ERRORS

Constantinos Philippides (M.S. Thesis) Aug. 1966 143 p refs
(Contract NOw-62-0604-c)
(TG-843; AD-644691) CFSTI: HC $3.00/MF $0.65

Investigation of the physical limitations of a pulse compression system due to random phase errors is presented analytically and experimentally. Phase errors influence the performance of a pulse compression radar. Random phase errors are involved in this analysis, and form a statistical problem. A theory is formulated treating their effects on the range and Doppler responses of a matched filter receiver. It is necessary to introduce the concept of moments for the statistical analysis of resolution and main lobe shift. The statistical maximum fractional reduction in gain is formulated. The degradation of a discrete pulse compression system is examined. Normally distributed random phase errors are generated and introduced into the Simoramic spectrum analyzer. Their effects on the response output are analyzed. Main lobe broadening, shifting, and peak loss are tabulated and illustrated for different sequences of phase errors. The sidelobe structure also deteriorates. For high phase errors the higher sidelobes totally mask the signal. Author (TAB)

N67-19850# Naval Research Lab., Washington, D. C.
THE HARTLOBE AIRBORNE DUAL ANTENNA SYSTEM FOR IFF. PART I: MARK X (SIF) SYSTEM Interim Report
Gerald E. Hart, Charles E. Quigley, and F. D. Mattison 18 Oct. 1966 34 p refs
(NRL-6401; AD-643694) CFSTI: HC $3.00/MF $0.65

The experimental model (Plan 1) of the Hartlobe airborne dual antenna system for IFF which was successfully flight tested by NATC had an inherent problem caused by gain-time-control (GTC) action in the interrogator receiver. An improved model, designated Plan 2, which overcomes the GTC problem, has been developed. The GTC problem resulted from the fact that the bottom transponder was allowed to reply to all signals above its sensitivity threshold, while the top transponder was triggered only when the bottom unit did not reply. At certain aircraft aspects, the reply failed to register because of the GTC threshold. This problem was overcome by circuitry which compares the signal levels in the two receivers and directs the reply via the antenna which produced the strongest received signal. It is proposed to implement the Hartlobe system by utilizing components of the AN/APX-72 transponder or other lightweight transponder capable of easy separation into rf and video portions. Author (TAB)

N67-19860*# Douglas Aircraft Co., Inc., Santa Monica, Calif. Missile and Space Systems Div.
REPORT ON THE DEVELOPMENT OF THE MANNED ORBITAL RESEARCH LABORATORY (MORL) SYSTEM UTILIZATION POTENTIAL. TASK AREA IV: MORL SYSTEM IMPROVEMENT STUDY, BOOK 4
D. C. Born (IBM) and D. R. Andelin Dec. 1965 147 p refs
(Contract NAS1-3612)
(NASA-CR-66291; SM-48818) CFSTI: HC $3.00/MF $0.65 CSCL 09F

Evaluated are potential improvements to the MORL, and also those improvements stemming from investigations aimed at increasing the effectiveness of the orbiting station through addition of new system elements. Results of analyses performed on the communications and telemetry subsystem indicate the feasibility of designing a unified communication system for MORL that utilizes the major elements of the Apollo unified S-band system ground stations. The optimum design for such a system reflects an updated communication baseband configuration incorporating an advanced data management system study. G.G.

N67-19861*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THE GSFC SCIENTIFIC DATA STORAGE PROBLEM
Allan M. Demmerle (Natl. Inst. of Health), Richard G. Holmes, and William B. Poland Jan. 1967 16 p refs
(NASA-TM-X-55714; X-563-67-82) CFSTI: HC $3.00/MF $0.65 CSCL 09D

Depicted is the Goddard Space Flight Center's continuing program in the field of archiving for telemetry data. The functional configuration of the data archive is represented by the introduction of raw data into the archive and the withdrawal of data in response to retrieval requests, based on a basic set of descriptors. Some of the problems associated with long term storage of data on magnetic tape are: (1) cost of the data stored in regard to the material cost; (2) print-through of data from one layer to the next; (3) blocking by layer to layer adhesion; (4) mechanical distortion of the tape; (5) erasures due to stray magnetic field; and (6) sensitivity to the environment. Periodic controlled rewinding of the tape and storage in a controlled environment involve costly procedures, and various alternate solutions of the problems are considered. A basic plan evolved to transcribe the data from magnetic tape on a two different medium less expensive than tape, and the possible use a of a computer for indexing, record keeping, etc. G.G.

N67-19866* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
X/Y ANGLE AND POLARIZATION ANGLE TRACKING OF THE ATS-B SPACECRAFT USING THE ROSMAN 85-FOOT ANTENNA NO. 2 AND MOJAVE 40-FOOT ANTENNA
Thomas Keating Feb. 1967 85 p
(NASA-TM-X-55716; X-513-67-95) CFSTI: $3.00 CSCL 17I

The 85-foot-diameter and 40-foot-diameter Cassegrain parabolic antennas located at Rosman, North Carolina and Mojave (Goldstone Dry Lake), California are used to track the ATS-B spacecraft. These antennas are required to automatically track the position of the spacecraft and the plane of the linearly polarized r-f wave radiated by the spacecraft antennas. The report describes the design features of the equipment and the performance of the tracking systems in support of the ATS-B launch operations. Author

N67-19869* Atlantic Research Corp., Alexandria, Va.
ELECTROMAGNETIC INTERFERENCE STUDY, PHASES I, II, AND III
Nov. 1966 101 p
(Contract NAS12-113)
(NASA-CR-80005) CFSTI: $3.00 CSCL 09F

This report describes the electromagnetic interference (EMI) measurements performed at the temporary location of the National Aeronautics and Space Administration (NASA) ERC at 575 Technology Squre, and at the building site for the permanent location, at Kendall Square, Cambridge, Massachusetts. Measurements also were performed at the home office of Jansky & Bailey in Alexandria, Virginia, to determine the EMI shielding properties of several types of building materials. Data obtained from the above-cited measurements were used in providing recommendations to ERC for facility design criteria for reduction of EMI. Author

N67-19870*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
SPACE PROGRAMS SUMMARY NO. 37-43, VOLUME III FOR THE PERIOD NOVEMBER 1 TO DECEMBER 31, 1966. THE DEEP SPACE NETWORK
31 Jan. 1966 156 p refs
(Contract NAS7-100)
(NASA-CR-82940; JPL-SPS-37-43, Vol. III) CFSTI: HC $3.00/MF $0.65 CSCL 17B

Discussed are the capabilities of the Deep Space Network to simultaneously control either two newly launched spacecraft plus two in flight, or four spacecraft in flight, as well as the implementation of advanced communications techniques to make it possible to obtain data from, and tracking spacecraft to, planets as far out in space as Jupiter. Depicted studies cover the following topics: (1) *Tracking and Navigational Accuracy Analyses*—tracking station location determination, range data compression, lunar orbiter data evaluation, angle observations for precise orbit determination, etc.; (2) *Communications Research and Development*—microwave maser, atomic frequency standard, refrigerated transmission lines, efficient antenna systems, digital communication and tracking, etc.; (3) *Communications Development Engineering*—high power transmitter development, and Mariner IV signal evaluation; (4) *Facility Engineering and Operation*—flight project support, construction and equipment, Venus DSS operation, etc.; (5) *Operations Program*—Surveyor and lunar orbiter software, computer program for antenna pointing, bit-string data processing procedure, etc. G.G.

N67-19878* Wheeler Labs., Inc., Great Neck, N. Y.
DEVELOPMENT AND PERFORMANCE OF A SMALL CROSSED-LOOP OMNIDIRECTIONAL UHF PROTOTYPE ANTENNA FOR A PENETROMETER Final Report
Robert E. Puttre 30 Jan. 1967 50 p refs
(Contract NAS1-4470)
(NASA-CR-66295; Rept.-1395) CFSTI: $3.00 CSCL 09F

A turnstile antenna with isotropic-like radiation coverage was evaluated for use in an impact-measuring instrumented projectile. The antenna comprises a pair of orthogonal loops fed in phase quadrature. The pattern-test models are self-contained units comprising two antenna loops and the impedance-test models essentially comprise a single antenna loop about a central core, encapsulated in an epoxy-resin sphere. Radiation patterns and impedance of the test models were measured in free space and as the models approached, made contact with, and were immersed in a bed of dry masonry-grade sand. The free-space radiation patterns indicate a 4 db variation of radiated power about the full direction sphere. The measured antenna efficiency for the 250 Mhz and 450 Mhz models are 12% and 34%, respectively. The results of the measurements of the radiation resistance and change of reactance of the 250 Mhz model near and submerged in the sand bed correspond with previous theoretical predictions. Author

N67-19924* Collins Radio Co., Dallas, Tex.
EXPERIMENTAL STUDIES OF CURRENT DISTRIBUTIONS AND RADIATION PATTERNS OF A RESISTIVELY LOADED V-ANTENNA AT QUARTER SCALE FOR A RADIO ASTRONOMY EXPLORER SATELLITE Final Report
30 Nov. 1966 155 p refs
(Contract NAS5-9255)
(NASA-CR-82966; Rept.-523-0559124-00133M) CFSTI: HC $3.00 CSCL 09F

The radiation patterns and impedance of the V-antenna were obtained at approximately one-fourth scale. These patterns were determined for three-wire configurations representing bending about the nominal straight wire V resulting from the thermal bending, gravity gradient, and centrifugal force effects. Impedances were measured for the straight wire and one curved wire configuration. The radiation patterns were obtained by measuring the current on one-half the V-antenna, mounted over a large ground plane, first using a modulated perturbation field probing technique, then using these currents to calculate the patterns on an electronic computer. The original current data and a copy of the computer program are provided, which give the radiation pattern every 3° in increments of both spherical angles. The impedance is presented both in tabular and Smith Chart form. Aside from the V-antenna results presented as a requirement of the study, the modulated perturbation field probing technique has wide application and can be used to measure radiation patterns directly with additional development. Author

N67-19938*# Harvard Univ., Cambridge, Mass. Computation Lab.
SEQUENTIAL CODING SCHEMES FOR AN ADDITIVE NOISE CHANNEL WITH A NOISY FEEDBACK LINK Technical Report, May.–Aug. 1966
R. L. Kashyap Aug. 1966 37 p refs
(Grant NGR-22-007-068; Contract Nonr-1866(16))
(NASA-CR-82935; TR-508) CFSTI: HC $3.00/MF $0.65 CSCL 09F

A coding scheme for additive Gaussian channel is developed using a noisy feedback link and D-dimensional elementary signals with no band width constraint. This allows error free transmission at a rate $R < R_c$ where R_c is slightly less than the channel capacity C. When there is no noise in the feedback channel, the coding scheme reduces to a D-dimensional generalization of the coding scheme of Schalkwijk and Kailath. In addition, the expression for the probability of error is determined when T, the time of transmission rate is finite. Our scheme is also compared with the best codes which use only the forward channel. Author

N67-19942*# Brown Engineering Co., Inc., Huntsville, Ala. Scientific Research Labs.
OVER-THE-HORIZON TRANSMISSION AT 136 Mc/s
N. F. Six, Jr. Jun. 1963 16 p refs
(Contract NAS8-2495)
(NASA-CR-82956; R-50) CFSTI: HC $3.00/MF $0.65 CSCL 09F

The degree of over-the-horizon propagation that may be reasonably expected at a frequency of 136 Mc/s is considered for vehicle altitudes ranging from 10,000 feet to 200 kilometers. It is shown that over-the-horizon transmission due to ionospheric and lower atmospheric refraction results in a "look angle" below the horizon of less than 0.2°. Author

N67-19978# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
A DOUBLE MIRROR ANTENNA WITH AUTOMATIC COMPENSATION OF THE PHASE ERRORS
A. L. Ayzenberg and L. N. Deryugin 2 Sep. 1966 5 p Transl. into ENGLISH from the Russian Patent no. 170556 (Appl. no. 896515/26-9, 23 Apr. 1964) 2 p
(FTD-HT-66-94; AD-643713) CFSTI: HC $3.00/MF $0.65

The object of the invention is a two-mirror antenna with automatic compensation of the phase errors, which consists of a horn exciter, a large and a small mirror, and also a system for controlling the actuators and an indication of the phase errors, is different in that to decrease the phase errors in the antenna aperture and to ensure the possibility of increasing the antenna gain, in it the small mirror is divided into separate sections that are equipped with actuators for their automatic shifting and the system of automatic phasing has a feedback circuit with respect to the phase of the high-frequency field through the space between the large and small mirrors. Author (TAB)

N67-20164*# Hughes Aircraft Co., Culver City, Calif. Aerospace Group.
ADVANCED DEEP SPACE COMMUNICATION SYSTEMS STUDY Final Report
E. C. Park, L. L. Bailin, J. F. Cashen, D. C. Forster, R. R. Gold et al Jan. 1967 307 p refs
(Contract NAS12-81)
(NASA-CR-82879; P67-15) CFSTI: HC $3.00/MF $0.65 CSCL 17B

Results are presented of a study to define areas of technology where research effort can best be expended in order to meet deep space communication needs in the period 1970 to 1980. The communication system requirements are discussed for deep space missions with reference to transmission range, data rate, and angular coverage. Basic limitations to system performance are reviewed, and include minimum signal requirements, noise sources and their spectral characteristics, and atmospheric attenuation and distortion effects. Practical limitations on performance due to the present and projected state of technology are discussed with reference to radio frequency and optical components. Based on the various performance limitations expected communication link performance is analyzed as a function of frequency to determine suitable frequencies and system configurations. A review of the present state of the art in radio frequency and optical technology, a discussion of potential developments, and an indication of promising areas for research are included. C.T.C.

N67-20167* Douglas Aircraft Co., Inc., Newport Beach, Calif. Astropower Lab.

RESEARCH ON THE UTILIZATION OF PATTERN RECOGNITION TECHNIQUES TO IDENTIFY AND CLASSIFY OBJECTS IN VIDEO DATA Technical Progress Report, 30 Jul. 1966–31 Jan. 1967

R. D. Joseph Feb. 1967 43 p
(Contract NAS12-30)
(NASA-CR-80012; SM-48464-TPR-4) CFSTI: $3.00 CSCL 09D

This report covers items concerned with improving the generalization performances achieved in earlier experiments by manipulations of the patterns, and by augmenting known properties with statistically derived properties. Generalization percentages have been improved significantly, with performances over 92 percent having been recorded for four of the five recognition tasks. For the remaining task, performance was raised to 84-1/2 percent. It is felt that the generalization figures are commensurate with the quality of the patterns–that is, the equal of the performance of human observers dealing with the digitized patterns. Author

N67-20188# Environmental Science Services Administration, Boulder, Colo. Inst. for Telecommunication Sciences and Aeronomy.

PREDICTING STATISTICAL PERFORMANCE INDEXES FOR HIGH FREQUENCY IONOSPHERIC TELECOMMUNICATIONS SYSTEMS

Donald L. Lucas and George W. Haydon Aug. 1966 182 p refs Sponsored by Navy
(IER-1-ITSA-1; AD-644827) CFSTI: HC $3.00/MF $0.65

Methods for predicting the performance of high frequency ionospheric telecommunication systems are revised to include recent improvements in the basic ionospheric and geophysical data. Revised techniques for the processing of this data by high speed electronic computers is described in detail with emphasis on better statistical descriptions of the expected performance of radio systems depending upon ionospheric propagation of radio waves. The application of the prediction techniques to communication problems is illustrated and the concept of service probability in ionospheric telecommunication systems is introduced. Comparisons between predictions and circuit operations are shown.
Author (TAB)

N67-20194# Lincoln Lab., Mass. Inst. of Tech., Lexington.

NOISE TEMPERATURE OF AIRBORNE ANTENNAS AT UHF

George Ploussios 6 Dec. 1966 54 p refs
(Contract AF 19(628)-5167)
(ESD-TR-66-237; TN-1966-59; AD-644829) CFSTI: HC $3.00/MF $0.65

Partial results of an experimental program to determine the electromagnetic noise environment at UHF on board an aircraft are presented. Contributors to an airborne receiver noise temperature including galactic noise, earth temperature, P-static, atmospherics and industrial noise were measured and are discussed. A model of the industrial noise is presented whereby the industrial area is considered as a uniformly distributed source of independent radiators, the magnitude being the same for all cities measured with the exception of the New York City area. RFI generated by on-board equipment and/or ground transmitters will be covered in a subsequent report. Author (TAB)

N67-20197# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

A METHOD OF MEASURING CODING ERRORS

A. G. Likiardopulo and Yu. V. Markov 2 Sep. 1966 5 p Transl. into ENGLISH from Russian Patent no. 169294 (Appl. no. 825255/26-24, 15 Mar. 1963) p 1–2
(FTD-HT-66-92; AD-643711) CFSTI: HC $3.00/MF $0.65

The object of the invention is a method of measuring the coding error of coders with parallel output and cyclic code is different in that, to increase the rate of measuring the error and to directly obtain the mean or root-mean-square error, a standard sawtooth voltage is periodically fed to the input of the coder and on the output replacement instants of the coded combinations are compared with a standard sequence of pulses that are synchronized with the standard sawtooth voltage and pulses are distinguished that are proportional, in duration and sign, to the coder error at separate points of the coding, and double integration or one-sided inversion with double integration produces the mean or the root-mean-square error of the coder, which is recorded by an indicator. Author (TAB)

N67-20293# European Space Research Organization, Paris (France).

SATELLITE LOCALIZATION SYSTEMS [SYSTEMES DE LOCALISATION DES SATELLITES]

J. Le Peltier (European Space Technol. Center, Delft, Netherlands) Oct. 1966 51 p In FRENCH; ENGLISH summary Presented at the ESRO Summer School, Oxford, 1964
(ESRO-TM-42) CFSTI: HC $3.00/MF $0.65

An introductory section deals with the accuracy of theoretical determination of an earth-satellite trajectory. The purposes of a satellite location system are then listed, followed by a discussion of the limitations on the accuracy of such systems due to physical causes and to instrumental and goedesic causes. Determination of satellite location by optical measurement is mentioned and a full account of radioelectrical techniques (radars, interferometers, and systems using the Doppler effect) is given, with a discussion of the advantages and disadvantages of each. Improvements to the conventional radar are described. As an example of an interferometer, the Minitrack system is described in some detail. Finally, the use of composite systems is mentioned and the U. S. range and range system is described as an example. Author (ESRO)

N67-20364# Aerospace Corp., El Segundo, Calif. Electronics Research Lab.

RADAR WAVEFORMS FOR SUPPRESSION OF EXTENDED CLUTTER, 1 FEBRUARY–15 JUNE 1966

A. W. Rihaczek and R. L. Mitchell Nov. 1966 38 p refs
(Contract AF 04(695)-669)
(TR-669(6230-46)-10; SSD-TR-66-223; AD-644214) CFSTI: HC $3.00/MF $0.65

Target detection in the clutter from extended fields of scatterers, such as the ground or the sea, is a common problem

in radar. Having optimized the system configuration, the designer can further improve radar performance by adapting the transmitted waveform to the particular target environment. This problem is investigated here for detection of a single target in the presence of an extended clutter space. The paper considers the possibility of confining the matched-filter response in delay and Doppler, or ambiguity function, to a narrow strip with arbitrary orientation in the delay-Doppler domain. It is shown that strict confinement of the response is achievable only with waveforms that are unlimited in both time and frequency domain. In practice, efficient use of the frequency band requires that the spectrum be truncated, so that strict confinement of the response is not achievable. One finds that bandwidth can be traded against visibility in clutter. More generally, for a fixed bandwidth, the trade-off is between close-target separability and detectability in the clutter, which are the two tasks that together constitute the resolution problem. The paper illustrates the effects of spectrum truncation for the important case of maximum confinement of the ambiguity function. Author (TAB)

08 COMPUTERS

Includes computer operation and programming; and data processing. For basic research see: 19 Mathematics.

N67-19434# Oak Ridge National Lab., Tenn.
DATA COLLECTION AND ANALYSIS
In its Instrumentation and Control Div. Ann. Progr. Rept., for Period Ending Sep. 1, 1965 Aug. 1966 p 75–90 refs (See N67-19423 09-14) CFSTI: HC $3.00/MF $0.65

Summary information is presented on the activities of the data processing and analysis group involved in computer programming, as well as interface programming progress for the Oak Ridge National Laboratory. To increase the data handling the acquisition capabilities of the alpha experiments, a system was developed with a general purpose digital computer as the data-accumulating device. The thermocouple calibration computer program was revised and expanded. Also fourteen section titles are listed for a work describing smoothed thermocouple tables of extended significance. R.Ll.

N67-19452# Naval Ammunition Depot, Crane, Ind.
TWO-DIMENSIONAL FLIGHT COMPUTER PROGRAM
Ralph Chipman 21 Sep. 1966 36 p refs
(RDTR-83; AD-640666) CFSTI: HC $3.00/MF $0.65

This report described a two-dimensional flight computer program written for the IBM 1620 computer. The program is used to calculate the trajectory and instantaneous velocity of an object that is projected upward from the ground at any angle or projected or released from an aircraft. Mathematical derivation, options for using, and computer operator instructions are presented. Also, included are certain checks that were made to compare the accuracy of the program with bombing tables, range tables, and theoretical equations. Author (TAB)

N67-19470# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
SCIENTIFIC TECHNICAL INFORMATION Selected Articles
21 Jun. 1966 51 p refs Transl. into ENGLISH from Nauchn.-Tekhn. Inform. (USSR), no. 6, 1966 p 25–26, 27–36
(FTD-TT-65-1880; TT-66-62436; AD-640294) CFSTI: HC $3.00/MF $0.65

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2. ANSWER FROM ASSOCIATIVE MEMORY V. F. Rudakov and Ye. I. Il'yashenko p 9–44 refs (See N67-19472 09-08)

N67-19471# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
A SEARCH FOR INFORMATION ON SENSUAL CODES
L. E. Pshenichnaya and E. F. Skorokhodka *In its* Sci. Tech. Inform. 21 Jun. 1966 p 1–8 ref (See N67-19470 09-08) CFSTI: HC $3.00/MF $0.65

Principles are explained which are the basis of experimental information-search systems developed at the cybernetics institute of the Academy of Sciences Ukr-SSR. The content of documents and inquiries is presented in the form of sensual codes, reflecting important signs of corresponding concepts. A comparison of sensual codes permits a determination of the degree of sensual generality, hypothetical sensual generality, unconditional sensual closeness, and hypothetical sensual closeness. Author

N67-19472 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
METHODS OF SELECTING A MULTIVALENT ANSWER FROM ASSOCIATIVE MEMORY
V. F. Rudakov and Ye. I. Il'yashenko *In its* Sci. Tech. Inform. 21 Jun. 1966 p 9–44 refs (See N67-19470 09-08) CFSTI: HC $3.00

A brief review is given of methods described in literature of extracting a multivalent answer from an associative memory. A method is discussed for extracting a multivalent answer from associative memory with an individual detector per word, at which, for selection of all words corresponding to the given associative criterion, is necessary only one inquiry of the memory part of associative memory with subsequent turning only to detector matrix. Two systems of detector matrix are proposed. System I reduces to a terminal minimum the number of turning to the detector matrix; it is distinguished by high speedy action, but requires more equipment. According to system II the amount of equipment is sharply reduced, but the time of inquiring the detector matrix increases somewhat. This system is convenient for associative memory of greater volume. Experimental results are given which confirm the possibility of realizing the proposed systems of detector matrix. Author

N67-19476# Argonne National Lab., Ill.
ON-LINE CALCULATIONS WITH THE CDC-3600 COMPUTER USING AN AUTOMATIC-PRIORITY INTERRUPT
R. O. Lane *In its* Phys. Div. Apr. 1966 p 4–5 (See N67-19474 09-24) CFSTI: HC $3.00/MF $0.65

A sophisticated mode of operation using the ASF-2100 computer as a satellite of the CDC-3600 is described. In this mode, the experimenter on the 4.5 MeV Van de Graaff interrupts the normal production computations on the CDC-3600 and obtains extensive major computations on his data, after which the CDC-3600 automatically resumes normal production. In this priority interrupt mode, data from the detectors used in the neutron scattering and polarization experiment are automatically accumulated on a few punched cards. A command word instructs the card reader to transfer data to the 2100 and then onto the data tape. The program name for the desired calculation is typed which instructs the 2100 to interrupt the 3600 and information relevant to the interrupted computation is dumped from the computer memory onto the scratch tape. The called program is then read

from the PHYLIS library tape into the 3600 memory. Experimental data are transferred from the data tape across the link to the 3600 which performs the computations. Results are transmitted back across the link to the data tape at the 2100. The information that was in the memory at the moment of interrupted computation is read back into the 3600's memory at the moment of and it resumes production. Meanwhile, the results received by the 2100 are printed out. R.N.A.

N67-19667# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. Dept. of Electrical Engineering.
DIGITAL COMPUTER USER'S MANUAL FOR EE STUDENTS AND FACULTY
C. H. Houpis Mar. 1966 56 p refs
(AD-638023) CFSTI: HC$3.00/MF$0.65

The manual is intended to give the reader some useful digital computer programs and hints that will enable and encourage him to use the computer more effectively for solving many of his assigned homework problems. The manual can also be of use in a student's pursuit in doing his thesis. Author (TAB)

N67-19684# Northwestern Univ., Evanston, Ill. Systems Lab.
ASSOCIATIVE MEMORY SYSTEMS AND THEIR APPLICATIONS TO PICTURE AND ARITHMETIC PROCESSES
Chao-Chih Yang Aug. 1966 86 p refs
(Contract N00014-66-C0020-A03; Grant AF-AFOSR-98-65)
(TR-66-103; AD-641205) CFSTI: HC$3.00/MF$0.65

Two different associative memory systems implemented by cryotrons and cutpoint cells are presented. The cutpoint cellular associative memory designed on the basis of stage delay analysis does not use any ladder structure, but employs a high-speed controlled shift register for the sequential tagging of all matched memory words. Both systems are so mechanized that their structures are simple and especially compatible with the batch fabrication of integrated circuits. Moreover, both systems can perform ordered information retrieval following Lewiss sorting scheme, template-matching pattern recognition based on the union-intersection concept and nonbulk two-summand additions of signed binary numbers in the signed-2s-complement number system. The basic operations of each system include comparison, reading, writing, sensing and output-summing processes being all performed on the basis of parallel-by-bit. During simultaneous comparison, a bit-position corresponding to all bit-memories of equal significance can be masked out. The processing system for arithmetic operations consists of an associative memory, right shift registers and Mealy type sequential machines. Author (TAB)

N67-19712# Carnegie Inst. of Tech., Pittsburgh, Pa. Management Sciences Research Group.
PROBABILITY MODELS FOR MULTIPROGRAMMING COMPUTER SYSTEMS
Donald P. Gaver, Jr. Sep. 1966 39 p refs
(Contract Nonr-760(24))
(Rept.-84; AD-640706) CFSTI: HC$3.00/MF$0.65

A probability model is developed for a computer system that is capable of multiprogramming, i.e., that maintains several program segments simultaneously in Main Memory (core), the latter being served by several input-output channels. Under various probabilistic assumptions, reflecting the mixture of jobs submitted to the system, the productivity of systems of various configurations is studied. Author (TAB)

N67-19775# RAND Corp., Santa Monica, Calif.
CURRENT TRENDS IN AEROSPACE COMPUTATION AND SOME IMPLICATIONS
Barry Boehm Nov. 1966 15 p refs Presented at SSD/Aerospace Workshop on Spaceborne Computer Software, El Segundo, Calif., 20 Sep. 1966
(P-3484; AD-643964) CFSTI: HC$3.00/MF$0.65

Three major trends in aerospace computing are discussed: (1) Computing power is increasing rapidly; (2) The range of applications is widening rapidly; (3) Software is scrambling to keep up with the other two. Author (TAB)

N67-19778# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
OPERATING COMPUTER SYSTEM "PROKAT"
N. S. Nikolayev and V. L. Epshteyn 8 Dec. 1966 15 p refs Transl. into ENGLISH from the Book "Avtomaticheskoye Operativnoye Upravleniye Prizvoostvennymi Protsessami" Moscow, Izd. Nauka, 1965 p 134–140
(FTD-HT-66-613; TT-67-60193; AD-643623) CFSTI: HC $3.00/MF$0.65

Because of the high cost of operating industrial plants, computers are necessary for the simultaneous control of the different departments making up the whole operation. A large amount of information must be stored in the computers. This report concerns the Controlling Computational Complex (PROKAT). At first the problem of industrial control was analyzed with a complex of computers. Losses and reserves of the metallurgical manufacturing process were evaluated. Solving this problem should lead to an increase in the heating pit temperature and productivity, and a reduction in specific fuel consumption and machine idling. A profit graph is shown which does not consider personnel reduction. The Martin shops use of a computer is described. PROKAT has five automatic local control systems, a centralized information system and a central control calculation machine. Local automatic controls control each section; the centralized control assures assembly, information accumulation, processing and documentation, while the calculating machine regulates the interaction of the different sections. The different functions are listed. A comparison of humans with the machines is given along with a specific operational description. Author (TAB)

N67-19834# Air Force Systems Command, Wright-Patterson AFB, Foreign Technology Div.
DIGITAL CONTROLLING MACHINE OF GENERAL INDUSTRIAL APPLICATION TSUM-1
5 Oct. 1966 16 p refs Transl. into ENGLISH from the Russian
(FTD-HT-66-183; AD-643926) CFSTI: HC$3.00/MF$0.65

The digital control machine TSUM-1 represents a small scale digital calculation machine (TSVM) on semiconductor instruments, provided with a contact device of contacting with the object (USO), including an information transformation device, block of comparing with settings, block controlling the actions and of the registration device. Author (TAB)

N67-19845# Air Force Systems Command, Wright-Patterson AFB, Foreign Technology Div.
MAGNETIC MEMORY DEVICE
T. K. Tsogoyev 9 Sep. 1966 4 p Transl. into ENGLISH from Soviet Patent no. 170750 (Appl. no. 902273/26-24, 28 May 1964) 2 p
(FTD-HT-66-99; AD-643702) CFSTI: HC$3.00/MF$0.65

The object of the invention is a magnetic memory device, which consists of interrogation leads, discharge leads and two plates, one of which is made from a material with high magnetic permeability and the other from a material with a square hysteresis

group, is different in that to realize nondestructive read-out and to simplify the technology of making the device, the plates have parallel grooves and the directions of the grooves on the adjacent surfaces of these plates are mutually perpendicular, the discharge leads being placed in the grooves of the plate from the material with a square hysteresis group and the interrogation leads being placed in the grooves of the plate from the material with high magnetic permeability. Author (TAB)

N67-19883* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

FORTRAN PROGRAM FOR COMPUTATION OF WEBER FUNCTIONS AND THEIR FIRST DERIVATIVES

Antra Priede and Gabriel Allen Washington, NASA, Mar. 1967 42 p refs

(NASA-TN-D-3833) CFSTI: $3.00 CSCL 09B

A description is given of a FORTRAN IV program for computing $D_\nu(x)$ and $(d/dx)D_\nu(x)$, which are the Weber function of order ν and argument x and its first derivative, respectively. The range of values is x[0, 30] and ν[1,200]. The computations are performed in double precision and the values are accurate to seven significant figures over most of this region. However, in the range x[5.5, $\sqrt{50}$] and $(x^2/4)+1 < \nu < (x^2/4)+13$, the accuracy is reduced. Included herein are tables of $D_\nu(x)$ and $(d/dx)D_\nu(x)$ with values listed at intervals of 1 in x and 5 in ν; the tables begin with x=0 and ν=4.5, but they omit part of the region covered by x[5.5, $\sqrt{60}$]. The program is so written to take advantage of asymptotic forms, recursion relations, and series computations at whatever combinations of ν and x these methods yield the desired accuracy in the shortest machine time. Author

N67-19908* TRW Systems, Redondo Beach, Calif.

USER'S GUIDE FOR THE DIGITAL TIME SERIES ANALYSIS PROGRAM, PHASE I AND II

D. Brown 1 Aug. 1966 252 p

(Contract NAS1-5632)

(NASA-CR-66315; TRW-05856-6001-R000) CFSTI: HC $3.00 CSCL 09B

The Digital Time Series Analysis Program is a general purpose package for the analysis of random stationary time series and their relationships. The major outputs are probability density estimation and spectral estimators. A choice of standard (correlations and Fourier transforms for spectra; histograms for probability densities) or novel techniques (recursive filtering for spectral estimates; orthogonal functions for probability estimates) may be specified. Up to twenty different channels of input data may be processed, conditioned by removal of the mean, corrected for bias, and subjected to a generalized preconditioning (shaping) filter with appropriate post-darkening of the output. The output options include the computation of auto- and cross-correlations, auto- and cross-covariances, auto- and cross-spectral densities, average frequency band width and duration in each spectral band, coherence, transfer function, inter-power, filter response functions, time to maximum cross-correlation, spectral confidence bands, mean, standard deviations, normalized third and fourth central moments, and orthogonal coefficients. Author

N67-19991* Clifton Precision Products Co., Inc., Clifton Heights, Pa.

RESULTS AND RECOMMENDATIONS BASED ON DEVELOPMENT OF A PROTOTYPE RESOLVER TO DIGITAL ENCODER Final Report

10 Feb. 1967 11 p Prepared in cooperation with Ditran Corp.

(Contract NA 20576)

(NASA-CR-82925) CFSTI: $3.00 CSCL 09B

The theory of operation of a resolver to digital converter is presented, and effects of resolver TR, phase shift, and nulls on converter accuracy and performance are discussed. Plots of the analog instrumentation errors were made and results are illustrated. The four main sources of errors were: tolerances (±.1%) of precision wire-wound resistors, finite gain of integrated operational amplifiers, non-ideal switches, and quadrature. In addition, a summary of predicted and measured errors is tabulated. S.P.

N67-20003# Lincoln Lab., Mass. Inst. of Tech., Lexington.

GRAPHICS Semiannual Technical Summary Report, 1 Jun.–30 Nov. 1966

Jack I. Raffel 9 Dec. 1966 8 p

(Contract AF 19(628)-5167; ARPA Order 691)

(ESD-TR-66-583; AD-643821) CFSTI: HC $3.00/MF $0.65

The new APEX display executive is operational. The compiler-compiler, VITAL, was used to generate a number of compilers, including one for a second version of CORAL. A CRT display sequence is being constructed which will incorporate both the newly designed conic waveform generator and a character generator, and will handle as many as ten display stations. The hardware and software for the first phase of the SDC network experiment are completed - experimentation is under way. Author (TAB)

N67-20004# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

MEMORY ELEMENT

V. I. Sulkhanov 9 Sep. 1966 4 p Transl. into ENGLISH from Soviet Patent no. 170747 (Appl. no. 872373/26-24, 25 Dec. 1963) 2 p

(FTD-HT-66-98; AD-643701) CFSTI: HC $3.00/MF $0.65

The object of the invention is a memory element, which contains two cores that are penetrated by the writing, reading and output windings, is different in that to accelerate the process of reading information and to reduce the power required during its operation, it contains a preliminary writing winding; the reading and writing windings pass through both cores identically, and the output winding and the winding for preliminary reading pass through one of the cores in the direction opposite to the direction of the reading winding. Author (TAB)

N67-20177# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

APPLICATION OF EQUIVALENT PROGRAMMING TO ALGORITHMIZATION OF CONTROL MACHINES [PRIMENENIYE METODOV EKVIVALENTNOGO PROGRAMMIROVANIYA PRI ALGORITMIZATSII UPRAVLYAYUSHCHIKH MASHIN]

V. T. Kulik 8 Dec. 1966 47 p refs Transl. into ENGLISH from Vychislitel'nay Tekhnika Dlya Automatizatsii Proizvodstva; Trudy Soveshchaniya (Moscow), 1964 p 49–82

(FTD-HT-66-516; TT-67-60266; AD-643995) CFSTI: HC $3.00/MF $0.65

The problem of the mutual application of control machines and a system of control as a whole of the control machine and of the control algorithm is examined. The problem of simplifying the algorithm is of prime importance as compared with the opposite problem, the assuring of the adaptation of the machine to the algorithm. It is noted that a simple and general method of obtaining the optimal algorithm consists in the direct sorting out of equivalent algorithms and comparing them in accordance with a given criterion of optimal quality. It is shown that the concrete application of the approach under consideration to the equivalent programming requires study and development of the principles of

improvement and methods of equivalent conversion of the algorithms. The author lists a number of general practical principles effective for a sufficiently wide class of algorithms. Methods of simplifying the algorithms given by differential equations (systems of control) based on the reduction to equivalent formulas are examined. Many formulas are used, and ten tables are given. One table shows the analogy existing between the indices of the quality of the systems (machines) intended for realization of the algorithms and the corresponding characteristics of the algorithm. Author (TAB)

N67-20192# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

ALGORITHMIC DESIGNING OF CALCULATING DIGITAL COMPUTERS

V. S. Linskiy 8 Aug. 1966 116 p refs Transl. into ENGLISH of the Book "Algorithmicheskoye Proyektirovaniye Vychislitel'nykh Tsifrovykh Ustroystv" Moscow, Izv. AN SSSR, 1963 p 1–134 (FTD-MT-65-170; TT-67-60249; AD-643919) CFSTI: HC $3.00/MF $0.65

Contents: Arrangement of Elements of Digital Computers; Placement of Wires; and Formalization of Coordination and Control of Logical-Time Diagrams. TAB

N67-20335 Royal Aircraft Establishment, Farnborough (England).

AN INTRODUCTION TO MERCURY PROGRAMMING FOR PUNCHED CARD INPUT AND OUTPUT

K. Sanderson Aug. 1966 16 p (RAE-TR-66268) CFSTI: $3.00

Basic system characteristics and programming requirements for the punched card input and output systems of the Mercury computer are outlined. The card programs consist of a mixture of Mercury autocode instructions and Mercury machine code instructions. Some knowledge of the latter is required for complete understanding of the content of the report. Author

09 ELECTRONIC EQUIPMENT

Includes electronic test equipment and maintainability; component parts, e.g., electron tubes, tunnel diodes, transistors; integrated circuitry; microminiaturization. For basic research see: 10 Electronics. For related information see also: 07 Communications and 21 Navigation.

N67-19375# Israel Program for Scientific Translations, Ltd., Jerusalem.

ELECTRICAL CHARACTERISTICS OF AN ARTIFICIAL LINE WITH LOAD DISTRIBUTION IN STEADY-STATE OPERATION

M. F. Svin'in *In its* Elec. Instrumentation in High-Energy Phys., Collection of Papers No. 1 1966 p 125–135 refs (See N67-19361 09-23) CFSTI: HC $3.00/MF $0.65

A numerical analysis of an artificial line with large losses under zero-load conditions is presented. A four-terminal stage line is used as an illustration, and the characteristics of a single stage are identified as the propagation coefficient and characteristic resistances for propagation in opposite directions. Two cases are considered: when the generator is connected to one terminal and the other is open, and when the circuit input and output terminals are connected in parallel to the generator. Voltage amplitude distribution, voltage utilization coefficients, and methods of improving voltage distribution for a cascade voltage multiplier with capacitive coupling are also discussed. It was concluded that under certain conditions a voltage distribution, differing only slightly from voltage distribution along a line with characteristic impedance loading and without losses, can be obtained in the artificial line. N.E.N.

N67-19376# Israel Program for Scientific Translations, Ltd., Jerusalem.

A RESONANCE METHOD OF STUDYING DIAPHRAGMED WAVEGUIDES

V. L. Smirnov and N. B. Uspenskii *In its* Elec. Instrumentation in High-Energy Phys., Collection of Papers No. 1 1966 p 136–142 refs (See N67-19361 09-23) CFSTI: HC $3.00/MF $0.65

A resonance method of investigating the high frequency parameters of disk-loaded waveguides used as an accelerating system is described. The apparatus includes a reflex klystron which is frequency-modulated by a sawtooth sweep generator voltage. The high frequency power from the klystron passes through a power divider and coaxial tee simultaneously into the measuring, reference, and echo resonators. A thermostat is employed to maintain the temperature to within 0.1°C to avoid resonator frequency shifts due to temperature changes. The dependency of the frequency on pressure and the influence of discharging are also mentioned. It was concluded that the resonance method gives an accuracy of $\pm 2.2 \times 10^{-5}$ in the absolute frequency value, and $\pm 7 \times 10^{-6}$ in the relative frequency value. N.E.N.

N67-19424# Oak Ridge National Lab., Tenn.

NANOSECOND CIRCUITRY AND TECHNIQUES

In its Instrumentation and Control Div. Ann. Progr. Rept., for Period Ending Sep. 1, 1965 Aug. 1966 p 1–3 ref (See N67-19423 09-14) CFSTI: HC $3.00/MF $0.65

For noise attenuation and high-frequency performance, the noise and amplification of several new high frequency transistor amplifiers were investigated. The amplifier configuration that gave the best overall performance was the shunt-series feedback combination. Also in connection with the nanosecond circuitry and techniques research, a variable-rate kilovolt pulser was studied. A block diagram and brief technical details are presented on a mercury relay pulser design. R.L.I.

N67-19425# Oak Ridge National Lab., Tenn.

PULSE COUNTING AND ANALYSIS

In its Instrumentation and Control Div. Ann. Progr. Rept., for Period Ending Sep. 1, 1965 Aug. 1966 p 4–12 refs (See N67-19423 09-14) CFSTI: HC $3.00/MF $0.65

In the pulse counting and analysis program, technical progress is reported on the following: gating of a large area photocathode photomultiplier tube; wideband, low-noise, charge-sensitive preamplifier; elimination of undesirable undershoot in the operation and testing and nuclear pulse amplifiers; minimum-noise pulse shaping with new double delay-line filters in nuclear pulse amplifiers; versatile scaler with dc to 100 Mc capabilities; electronic gain control; stabilization system for a nuclear spectrometer; a system for identifying and analyzing charged particles; and the optimization of semiconductor preamplifiers for use with semiconductor radiation detectors. R.L.I.

N67-19426# Oak Ridge National Lab., Tenn.

ELECTROMETERS AND ACCESSORIES

In its Instrumentation and Control Div. Ann. Progr. Rept., for Period Ending Sep. 1, 1965 Aug. 1966 p 13–14 (See N67-19423 09-14) CFSTI: HC $3.00/MF $0.65

To determine their suitability in electrometer circuits, metal-oxide-semiconductor field-effect transistors (MOSFET's) were

evaluated. A current feedback electrometer with MOSFETS in a differential input stage was built to study noise, temperature dependence, parameter drifts with age, leakage current, and input capacity. Also reported is the development of a passive Fourier comb filter, using network synthesis techniques, for application in a chopper-modulated current amplifier. A maximally flat time-delay approximation, with predistortion for a Q-factor of 20, was used to synthesize a band-pass comb filter with center frequencies of 5, 15, and 25 kc. It was found experimentally that the signal-to-noise ratio at the output of the filter was improved by a factor of 16. R.Ll.

N67-19542# Ballistic Research Labs., Aberdeen Proving Ground, Md.
VHF AND UHF HIGH-G TELEMETRY INSTRUMENTATION FOR HARP VEHICLES
W. H. Mermagen, W. K. Cruickshank, and F. Vrataric (Harry Diamond Labs.) May 1966 34 p refs
(BRL-MR-1768; AD-640596) CFSTI: HC$3.00/MF$0.65

Telemetry systems capable of surviving gun-launched accelerations in the order of 60,000 g have been developed for the High Altitude Research Program (HARP). Such telemetry systems have been used to provide data on the flight dynamics of gun-launched vehicles as well as measurements of upper atmospheric phenomena. The results of measurements of electron densities and temperatures in the upper atmosphere are presented and discussed as examples of the data gathering capability of the HARP program. Vehicle roll rates and pitch-yaw frequencies have been measured during high altitude flights. The results are presented and some anomalous examples are discussed. It has been shown that the technique of using guns to launch instrumented payloads into the upper atmosphere is both practical and useful. Moreover, the inclusion of on-board instruments to observe the dynamical behavior of flight vehicles provides a useful tool for aerodynamic research in the real atmosphere. Author (TAB)

N67-19544# Motorola, Inc., Phoenix, Ariz. Semiconductor Products Div.
PRODUCTION ENGINEERING MEASURE FOR SILICON NPN SWITCHING TRANSISTORS Quarterly Progress Report, 25 Feb.–25 May 1966
Mark Siegel and Jack Freese 25 May 1966 32 p
(Contract DA-36-039-AMC-06164(E))
(I-22; QPR-4; AD-640894) CFSTI: HC$3.00/MF$0.65

Areas of progress during the quarter were as follows: (1) Incoming material specification change to substrate resistivity of 0.01 to 0.02 ohm/cm and breakdown voltage range of 80 to 100 volts has been approved and specifications issued. (2) New diffusion experiments to test narrower basewidths have been initiated. (3) Evaluation probe limits were adjusted and specifications issued. (4) New 10-mil-mask evaluation has been initiated. (5) A new Motorola photoresist is now under evaluation. (6) The cause of stress failures in environmental testing has been determined and appropriate measures were initiated to eliminate the failure mode. (7) metallization amounts have been standardized and specifications issued. (8) A new cascade rinse facility is now in production use. Author (TAB)

N67-19552# RAND Corp., Santa Monica, Calif.
A NEW APPROACH TO THE NUMERICAL SOLUTION OF A CLASS OF LINEAR AND NONLINEAR INTEGRAL EQUATIONS OF FREDHOLM TYPE
Richard Bellman Oct. 1966 9 p refs
(Contract AF 49(638)-1700; Proj. RAND)
(RM-4762-PR; AD-640687) CFSTI: HC$3.00/MF$0.65

A description is given of a new technique for the numerical integration of Fredholm integral equations. The approach appears to possess advantages in the case where k (u, v) > or = 0. The reader familiar with the theory of invariant imbedding, particularly its application to radiative transfer, will understand the motivation for the method, which can be applied with equal ease to various classes of nonlinear integral equations. Author (TAB)

N67-19554# Woods Hole Oceanographic Institution, Mass.
DATA REDUCTION OF STORMFURY 1965 CLOUD OBSERVATIONS MADE FROM RESEARCH FLIGHT FACILITY AIRCRAFT Final Report
Joseph Levine Sep. 1966 13 p refs *Its* Reference No. 66-50
(Contract CWB-11255)
(AD-639677) CFSTI: HC$3.00/MF$0.65

The data reduction procedures used on the observations obtained from the ESSA Research Flight Facility aircraft during the Stormfury 1965 operation is described. The results to be obtained eventually are cloud liquid water content, volume median drop size, turbulent vertical velocity, and buoyancy fluctuations in cloud passes made by the aircraft. Author (TAB)

N67-19668# Piezo Technology, Inc., Orlando, Fla.
PEM FOR FILTER, QUARTZ CRYSTAL 112 Mc, TYPE EL-FR(X-2) AND CRYSTAL UNIT, FILTER, QUARTZ TYPES CR(XM-64)/U AND CR(XM-65)/U Quarterly Progress Report, 1 May–30 Jul. 1966
R. B. Angove and R. J. Pruitt, Jr. 30 Jul. 1966 40 p refs
(Contract DA-36-039-AMC-03638(E))
(QPR-5; AD-640710) CFSTI: HC$3.00/MF$0.65

Conclusions: The shape factor of the first two sets of filter engineering samples deviates significantly from the requirement. This probably results from stray reactances and crystal static resistance but will be investigated more fully during the next quarter. It is unlikely, however, that the shape factor can be significantly improved from the performance of the second set of filters. A satisfactory method of final frequency calibration of the CR(XM-65)/U units has been developed and some progress has been made toward lowering static resistance. Author (TAB)

N67-19679# Weston Instruments, Inc., Archbald, Pa.
PRODUCTION FACILITIES FOR MULTI-TURN METAL-FILM TRIMMER RESISTORS PER MIL-R-22097B (MODIFIED) Final Report
F. Studer 19 May 1966 203 p refs
(Contract DA-36-039-SC-86734(E))
(AD-640711) CFSTI: HC$3.00/MF$0.65

The development of production facilities for the trimmer revealed unanticipated shortcomings in the film characteristics. A chemically deposited nickel film was found to be inherently better than an evaporated nickel-chromium film. Neither was found to approach the more demanding requirements of trimmer applications as compared to fixed resistor requirements. An extensive program designed to exploit the inherently better chemically deposited nickel failed to show correlations required to develop the film characteristics necessary for trimmer application. The need for additional fundamental research is evident. Production facilities were developed and it was demonstrated that these facilities could produce if it had been possible to control adequately the metallizing and heat treating of the film. These facilities offered the advantage of immediate scale-up in production via multiplicity. Author (TAB)

N67-19688# Rome Air Development Center, Griffiss AFB, N. Y.
SINGLE AND CASCADED WIDEBAND TRANSISTOR AMPLIFIERS

John B. Payne Sep. 1966 94 p refs
(RADC-TR-66-122; AD-641648) CFSTI: HC $3.00/MF $0.65

With the realization of high frequency transistors having current and power gain-bandwidth products in the gigacycle region, ultra wideband amplifiers are now possible. This report presents an analysis of the basic high frequency transistor configurations along with experimental data obtained from both single and multiple stage amplifiers having bandwidths ranging from 200 to 800 MHz. Included is a discussion of the important parameters that determine transistors high frequency response along with problems associated with layout and component selection. Various techniques for trading gain for bandwidth are treated and experimentally reported. A new approach for designing wideband cascaded amplifiers that require a minimum of adjustments yet yield near optimum performance is given. Author (TAB)

N67-19733# Clevite Corp., Bedford, Ohio. Piezoelectric Div.
PRODUCTION ENGINEERING MEASURE FOR CERAMIC FILTERS Quarterly Report, 30 Jun.–29 Sep. 1966
A. Lungo 29 Sep. 1966 17 p ref
(Contract DA-36-031-AMC-01471(E))
(QR-14; AD-642774) CFSTI: HC $3.00/MF $0.65

The poling of ceramic resonators for the preproduction filter samples and the production units was completed. In addition, all the frequency tuning and sorting of resonators for the 4.3 MHz and 6.0 MHz preproduction filter samples was completed. The preproduction 4.3 MHz wideband ladder filters and the preproduction 6.0 MHz ladder filters were processed to the sub-assembly stage. Final assembly was delayed because of a delay in the delivery of end seals. Also, during this period tests were conducted to evaluate the effect of the 1000 hour elevated temperature storage on one of the ceramic filters. The results are presented and discussed. Author (TAB)

N67-19814# Hughes Aircraft Co., Fullerton, Calif.
MICROMINIATURE MULTIPLANE INTERCONNECTION Third Quarterly Report, 1 Jan.–30 Jun. 1966
William T. Rhoades Ft. Monmouth, N. J., Army Electron. Command. Nov. 1966 187 p refs
(Contract DA-28-043-AMC-01439(E))
(FT-66-11-295; ECOM-01439-3; AD-643122)

The study has shown that an assembly of unmodified MCMs is thermally limited to 3 circuits per standard MCM using air cooling and a reasonable size blower (based upon 75C junction and 50C ambient). The addition of an external finned stud (.5 inches high) permits a maximum of 4 circuits per standard MCM with the same blower. If a shallow assembly of approximately 3.75 in. can be tolerated, the quantity of circuits can be increased to 5 per module with finned MCMs. If the design junction temperature is increased to 125C, the quantity of circuits per MCM may be increased to 12 or 16, depending on the blower size selected. Thermal considerations of the sandwich module shows that only the bottom of the flat package need to be bonded. This is because virtually all of the heat is transferred through the bottom of the package. The following approaches are being considered: (1) Direct air cooling using a centrifugal fan, (2) Direct air cooling using a tubeaxial fan, (3) Intermediate liquid cooling, (4) Ebullition or two phase cooling, (5) Mechanical refrigeration, (6) Thermoelectric cooling. The Fairchild ECL gate remains the preferred circuit for the assembly. Tests on this gate show that the average input capacitance is 4.20 pf, and the noise margins are: for the NOR + 165 mv and OR + 37 mv. These gates, as a latch flip-flop, can work up to 250 Mc. TAB

N67-19821# Radio Corp. of America, Somerville, N. J.
THIN-FILM POLYCRYSTALLINE FIELD-EFFECT TRIODE Final Report, 1 Jul. 1964–30 Jun. 1966
M. L. Topfer, J. J. Bowe, A. H. Danis, S. G. Ellis, J. J. Fabula et al Nov. 1966 139 p refs
(Contract DA-28-043-AMC-00231(E))
(Rept.-8; ECOM-00231-F; AD-643779) CFSTI: HC $3.00/MF $0.65

The report covers the work on the thin-film polycrystalline field-effect triode during the period of July 1, 1964 to June 30, 1966. All of the work on the contract is reviewed. The following work done during the eighth quarter is also covered. The behavior of the reversible gate instability at temperatures between −40°C and +60°C is discussed. The investigation was carried out to determine the variation of the instability mechanism with temperature. These initial measurements are too preliminary to draw conclusions. The masks for the four-input nor/or gate circuit were received, and the wire grille was fabricated. Initial trial runs with these masks to evaluate the alignment were completed and proved satisfactory. Fabrication of the integrated circuit was initiated. Work was initiated to investigate the controlled deposition and nucleation of semiconductor films, and an investigation of gate threshold shifts was carried out, in order to gain a better understanding of the mechanism of the TFT instability. Author (TAB)

N67-19829# Sylvania Electric Products, Inc., Woburn, Mass. Semiconductor Div.
PRODUCTION ENGINEERING MEASURE (PEM) FOR SILICON VARACTOR DIODE Quarterly Progress Report, 1 Apr.–30 Jun. 1966
G. Bowne and R. Bayliss 30 Jun. 1966 37 p
(Contract DA-36-039-AMC-06159(E))
(QPR-5; AD-643267) CFSTI: HC $3.00/MF $0.65

The fourth engineering test sample run has been initiated using the new package design, an improved tungsten whisker and a welded end seal. Tests have shown that the granular structure of the ceramic must be controlled if the package is to exhibit the desired mechanical characteristics. Step stress analysis of storage life test data on units from the third run show a failure rate of 0.03% per 1000 hours compared to the objective 0.001% level. TAB

N67-19842# Varo, Inc., Garland, Tex.
ENGINEERING STUDY OF ALL PRACTICAL STATIC FREQUENCY CONVERTER SYSTEMS, PHASE I. VOLUME I: BASIC REPORT Final Engineering Report
15 Oct. 1965 242 p refs
(Contract NObs-88657)
(EP-F4(I)-65, Vol. I; AD-644688) CFSTI: HC $3.00/MF $0.65

The purpose of Phase 1 of this program was to conduct a comprehensive analysis of all known practical approaches to static frequency-changer designs for converting 60-cps, 3-phase power to 400-cps, 3-phase power. It was also a purpose of this program to propose a means of comparing those systems analyzed by tabulating the advantages and disadvantages of each. Both theoretical and practical data were obtained and formulated in such a way that preferred designs can be selected readily, with selection based on desired characteristics. These desired characteristics have been measured against the three groups of parameters outlined in SHIPS-F-4424. Author (TAB)

N67-19852# General Electric Co., Lynchburg, Va. Communication Products Dept.
MICROMINIATURE CRYSTAL UNIT TYPE CR-(XM-47)/U PRODUCTION ENGINEERING MEASURE Quarterly Progress Report, 27 May–27 Aug. 1966

R. L. Hatcher 27 Aug. 1966 22 p
(Contract DA-36-039-AMC-06166(E))
(QPR-5; AD-644202) CFSTI: HC $3.00/MF $0.65

Establishes production techniques and demonstrates the capability of a pilot facility to manufacture reliable Microminiature Crystal Units Type CR-(XM-47)/U at a specified rate of 20 units per eight (8) hour shift. TAB

N67-19932*# Sylvania Electric Products, Inc., Waltham, Mass. Applied Research Lab.
WIDEBAND HIGH EFFICIENCY OPTICAL MODULATOR Final Report, 15 Feb. 1966–15 Mar. 1967
W. J. Rattman, B. K. Yap, and W. E. Bicknell 15 Mar. 1967 54 p refs
(Contract NAS8-20545)
(NASA-CR-82929) CFSTI: $3.00/MF $0.65 CSCL 09E

A project to develop two 100-MHz bandwidth electro-optic modulators and solid-state drivers which achieve 100 percent amplitude modulation with less than 10 watts modulator drive power is discussed. This report treats the design of this optical modulation system and the results of tests performed over the full 100-MHz bandwidth. Author

N67-19953*# Motorola, Inc., Phoenix, Ariz. Semiconductor Products Div.
SATURN INTEGRATED CIRCUIT RELIABILITY TEST PROGRAM Quarterly Progress Report, Jul.–Sep. 1966
W. F. Gunkel, M. R. Carpenter, and K. R. MacKenzie Sep. 1966 46 p
(Contract NAS8-18018, Proj. 1688)
(NASA-CR-82946; QPR-1) CFSTI: HC $3.00/MF $0.65 CSCL 09A

Investigated was the reliability of integrated circuits in order to develop screening tests for the dominant failure modes and mechanisms. The test samples represent three basic manufacturing processes. One device contains one compatible thin film die and one monolithic transistor die per device. Three other devices are of the single die all-diffused monolithic structure. Functionally, two represent a class of differential amplifiers, while the other two represent a class of operational amplifiers; and in one case, possible use as a high gain differential amplifier. Electrical parameter measurements and an analysis of the stress conditions on all elements within the integrated circuit are presented. K.W.

N67-19986*# Research Triangle Inst., Durham, N. C.
RELIABILITY ANALYSIS OF TIMING CHANNEL CIRCUITS IN A STATIC INVERTER
Jan. 1966 46 p refs
(Contract NASw-905)
(NASA-CR-82976; TR-6) CFSTI: HC $3.00/MF $0.65 CSCL 09E

A design reliability analysis is presented for the output circuitry of the timing section of a 250 volt-ampere static inverter. Circuit performance and life were used jointly as criteria for comparing three candidate circuits. Worst-case analyses utilizing simple models for circuit operation are used for performance considerations, and reliability prediction models employing both two- and three-state logic for components were used for life analyses. Consideration is also given to similar circuits such as the timing channel circuit No. 5 and the magnetic amplifier driver. S.P.

N67-20001# Westinghouse Electric Corp., Pittsburgh, Pa.
TUNED INTEGRATED CIRCUITS Quarterly Report, 1 Jul.–30 Sep. 1966
W. E. Newell and S. M. Zalar Dec. 1966 27 p
(Contract DA-28-043-AMC-02045(E))
(ECOM-02045-2; QR-2; Rept.-2; AD-643519) CFSTI: HC $3.00/MF $0.65

Apparatus and improved procedures for the vacuum co-evaporation of thick CdS films (5 to 15 microns) are described. A correlation between the thickness of CdS film piezoresonators, their resonant frequency and the electrode areas, required for the 50 ohm impedance matching, was worked out. First film resonances (as distinguished from substrate resonances) with Q of about 15 were observed in gold-CdS-gold piezoelectric structures, deposited on thin and thick glass substrates. TAB

N67-20019# Microwave Associates, Inc., Burlington, Mass.
Ku BAND SEMICONDUCTOR T-R DEVICE PRODUCTION ENGINEERING MEASURES PROGRAM Quarterly Progress Report, 27 Apr.–27 Jul. 1966
Paul Basken Aug. 1966 56 p refs
(Contract DA-36-039-AMC-06176(E))
(QPR-2; AD-643827) CFSTI: HC $3.00/MF $0.65

The report covers the fabrication and evaluation of the first set of eight engineering model limiters. As PIN diodes were not available for the first stage, all-varactor limiters were made. Four units were constructed with no reverse bias provision, the remaining four incorporated a biasing provision which can be used by the systems designer to obtain considerably lower insertion loss. A major portion of the report is devoted to the development effort leading to the optimized biasing network. A new method to evaluate the power handling capability of varactors through monitoring of the recovery time is also presented. The yield from the fabrication of varactors for the engineering samples is discussed. Author (TAB)

N67-20189# Rome Air Development Center, Griffiss AFB, N. Y.
COST RELIABILITY FACTORS IN HYBRID CIRCUIT PACKAGING
John E. McCormick Oct. 1966 23 p Presented at the 4th Ann. Natl. Electron. Packaging/Production Conf., New York, 21 Jun. 1966
(RADC-SP-66-9; AD-643969) CFSTI: HC $3.00/MF $0.65

Factors that affect reliability, (1) materials, (2) chip mounting techniques, (3) connecting techniques; a comparative reliability rating; factors that affect cost, (1) assembly techniques, (2) alinement techniques, (3) repairability, (4) yield; comparative cost rating; hybrid packing figure of merit. TAB

10 ELECTRONICS

Includes circuit theory; and feedback and control theory. For applications see: 09 Electronic Equipment. For related information see: Specific Physics Categories.

N67-19364# Israel Program for Scientific Translations, Ltd., Jerusalem.
AUTOMATIC CONTROL SYSTEM FOR THE FIELD OF A PROTON-SYNCHROTRON ELECTROMAGNET
F. M. Kulakov *In its* Elec. Instrumentation in High-Energy Phys., Collection of Papers No. 1 1966 p 13–33 refs (See N67-19361 09-23) CFSTI: HC $3.00/MF $0.65

The development and construction of an automatic control system (ACS) for the field of a proton–synchrotron electromagnet

with the following requirements is discussed: provision of the desired reproducibility of field increase and decrease from period to period; suppression of the high frequency ripple in the field increase curve B(t), and slow deviations of B(t) from its mean value during the interval of increasing field; and making the field decrease as quickly as possible. The structure of the ACS is described, and schematic diagrams are included. The differential equations that describe the ACS elements are given, and methods of obtaining the desired parameter variations in the interval of field increase and of field decrease are considered. The influence of perturbations on magnetic field variation are considered, including the instability of ACS parameters, instability of initial filter capacitor and converter voltages, and distribution and delay in feedback during ACS structure changing. It was concluded that the variable structure ACS satisfies all the stated requirements. L.E.W.

N67-19377# Israel Program for Scientific Translations, Ltd., Jerusalem.

A MEANS OF DETERMINING THE VOLTAGE IN THE GAP OF A CAVITY RESONATOR

I. G. Petelin *In its* Elec. Instrumentation in High-Energy Phys., Collection of Papers No. 1 1966 p 143–145 ref (See N67-19361 09-23) CFSTI: HC $3.00/MF $0.65

A method of measuring the voltage by determining an emf induced in the coupling loop of resonator and a measuring circuit is described. A system of equivalent resonator parameters is introduced, a relationship between the gap voltage and the loop current is given, and mathematical expressions are developed. It is concluded that the method is convenient, accurate, and can be used for the study of cavity resonators. N.E.N.

N67-19378# Israel Program for Scientific Translations, Ltd., Jerusalem.

PROPERTIES OF PULSED EXCITATION OF RESONANCE POWER SUPPLY SYSTEMS FOR HIGH ENERGY SYNCHRONIZATION ELECTROMAGNETS

R. S. Bobovikov, B. V. Platonev, F. M. Spevakova, and A. M. Stolov *In its* Elec. Instrumentation in High-Energy Phys., Collection of Papers No. 1 1966 p 146–159 (See N67-19361 09-23) CFSTI: HC $3.00/MF $0.65

The magnetic field intensity deviations for single-cycle and two-cycle pulsed alternating current sources are discussed, and an analysis of the transient process is presented. It is pointed out that the two-cycle system requires half the power of the single-cycle system, but causes deviations in the rate of magnetic field variation from the harmonic law during the acceleration cycle. The study of the transient process is limited to a system with a unit function as an input, and the process is analyzed by the finite difference method. Equations are developed to express the dynamic variations of the capacitor bank and resonance circuit voltages during the transient process. It is concluded that the two-cycle pulsed excitation for high energy synchrotron electromagnet is possible if the resulting distortions in the magnetic field intensity curve and its derivative do not exceed those permitted by particle motion. N.E.N.

N67-19441# Oak Ridge National Lab., Tenn.

ANALYSIS

In its Instrumentation and Control Div. Ann. Progr. Rept., for Period Ending Sep. 1, 1965 Aug. 1966 p 126–127 refs (See N67-19423 09-14) CFSTI: HC $3.00/MF $0.65

To accurately calculate the cross-power spectral density of two random noise signals, a new analog computer circuit was developed. This circuit enabled one to determine the transfer function of a device or a system when only the random fluctuations at the inputs and outputs are monitored. Tests on systems with known characteristics have shown the accuracies in calculating cross-power spectral densities of within 2% can be obtained, independent of the characteristics of the input noise signal. A digital computer code, simulating the analog analyzer, was also written and used to analyze digitized data directly. However, to obtain good results over wide frequency bandwidths, the data are usually digitized both at high and low sampling rates. R.U.

N67-19454# Syracuse Univ., Research Inst., N. Y.

NETWORK SYNTHESIS OF CASCADED THRESHOLD ELEMENTS Interim Report, Sep. 1964–Sep. 1965

W. S. Bennett, Jr. Griffiss AFB, N. Y., RADC, Sep. 1966 45 p refs

(Contract AF 30(602)-3197)

(RADC-TR-66-518; AD-640822) CFSTI: HC $3.00/MF $0.65

A threshold function is a switching function which can be stimulated by a single, simplified, idealized neuron, or threshold element. In this report, threshold functions are examined in the context of abstract set theory and linear algebra for the purpose of obtaining practical synthesis procedures for networks of threshold elements. A procedure is described by which, for any given switching function, a cascade network of these elements can be specified with which to simulate the given function. The techniques employed appear to be of potential value for the synthesis of more general network configurations. Author (TAB)

N67-19779# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

NEURON MODEL

N. V. Pozin and I. A. Lyubinskiy 9 Sep. 1966 5 p Transl. into ENGLISH from Soviet Patent No. 171179 (Appl. No. 901139/26-24, 20 May 1964) 2 p

(FTD-HT-66-103; AD-643709) CFSTI: HC $3.00/MF $0.65

There are neuron (nerve cell) models that contain input circuits, a generator node and one storage element that is common for all the stimulating inputs. These models do not consider the mutual effect of the processes in the dendrites and the soma of the neuron. In contrast to the known models, in the proposed model such interactions are considered. This is primarily attained by the fact that, instead of one common storage element, the model contains storage elements on each input. By connecting these storage elements with each other, or with the inputs, through functional elements the interaction of the inputs can be modeled, thereby obtaining a functional connection between the parameters of the input and output signals in the neuron model. Author (TAB)

N67-19795# Biometrics Instrument Corp., Plano, Tex. Static Power Div.

ENGINEERING STUDY OF ALL PRACTICAL STATIC FREQUENCY CONVERTER SYSTEMS. VOLUME II:

15 Oct. 1965 145

(Contract NObs-88657)

(EP-F4(I)-65; AD-644687) CFSTI: HC $3.00/MF $0.65

The illustrations and tables presented in this volume are referenced in the main body of the technical report presented in Volume I (AD-644 686). This method of presentation was adopted to simplify reference to these supplementary items, and to provide a less cumbersome report than would be presented in a single volume. TAB

N67-19826# RAND Corp., Santa Monica, Calif.

CONTROL PROBLEMS WITH LINEAR DYNAMICS, QUADRATIC CRITERION, AND LINEAR TERMINAL CONSTRAINTS

S. E. Dreyfus Dec. 1966 12 p refs
(P-3487; AD-644592) CFSTI: HC $3.00/MF $0.65

The paper examines a linear optimal regulator problem for which admissible trajectories must terminate on a specified hyperplane. The usual treatment leads to computationally unsatisfactory conclusions involving differential equations whose terminal boundary values are unbounded. The paper remedies this condition by re-expressing the problem so that the solution depends on Lagrange multiplier parameters which are determined so that optimal trajectories intersect the specified terminal hyperplane. Computations based on this procedure involve only finite quantities.
Author (TAB)

N67-19830# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
SYNTHESIS OF SCHEMES OF AUTOMATS FROM ELEMENTS WITH DIRECT CONNECTION
I. V. Matsevityy 14 Jul. 1966 10 p refs Transl. into ENGLISH from the Russian
(FTD-TT-65-1633; AD-644801)

A method is given for the construction of automatic schemes free from the phenome of chases without the use of delaying elements is explained. This method is suitable for the construction of schemes from elements with direct communication. Such schemes require fewer logical elements than methods ordinarily used.
Author (TAB)

N67-19831# Illinois Univ., Urbana. Coordinated Science Lab.
STABILITY OF NONLINEAR CIRCUITS WITH PERIODIC INPUTS
T. N. Trick Sep. 1966 29 p refs
(Contract DA-28-043-AMC-00083(E))
(R-320; AD-642500) CFSTI: HC $3.00/MF $0.65

A new method is presented by which the stability of nonlinear circuits containing bounded periodic sources can be determined. By stability we mean that the steady state output is unique and periodic with the same period as the input and all transients decay to this unique steady state solution. It is assumed that the first and second derivatives of the nonlinear function exist and are continuous within a certain allowable operating range of the nonlinear element. The first derivative should be positive at the bias point (not always necessary). A sufficient condition for the stability of the above circuit is given in terms of a maximum allowable input amplitude. However, it is shown that, given a certain upper bound on the input amplitude, the requirement that all transients decay to this unique steady state solution is too stringent and results in many computational problems, therefore, a small perturbation approach is adopted which results in fewer computations and less stringent conditions on the input amplitude. Experimental results indicate that this new approach is much better than previous results.
Author (TAB)

N67-19911*# Auburn Research Foundation, Inc., Ala. Digital Systems Lab.
THE REALIZATION OF TRANSFER FUNCTIONS WITH LOGICAL NETWORKS
C. C. Carroll Aug. 1966 52 p refs
(Contract NAS8-20163)
(NASA-CR-82914; TR-3) CFSTI: HC $3.00/MF $0.65 CSCL 09C

Three techniques for the synthesis of a network with a given transfer function are described. The synthesis techniques, which are based on approximation methods using sampled inputs, are derived using the convolution integral, with each method originating from a different approximation of the convolution integral. The purpose of this study is to determine the feasibility and the desirability of the digital implementation of a network with a given transfer function. The approach taken is entirely general and allows the techniques developed to be used in the realization of any transfer function. However, of the three techniques presented, the more advantageous technique will depend upon the specific problem under consideration. In synthesizing a particular transfer function, the required amount of circuitry for the implementation of the network will determine the technique used. All three techniques require a varying amount of logic circuitry for the implementation of a specific network.
Author

N67-19917*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
THE ANALYSIS AND CONFIGURATION OF A CONTROL SYSTEM FOR A MARS PROPULSIVE LANDER
Roy J. Mankovitz 15 Mar. 1967 23 p refs
(Contract NAS7-100)
(NASA-CR-82912; JPL-TR-32-1104) CFSTI: HC $3.00/MF $0.65 CSCL 09C

Several control-system mechanizations for a planetary propulsive lander are being studied. One of these, a soft-landing descent system that combines inertial and radar sensing techniques, controls the capsule from motor ignition to touchdown on the surface of a planet. A digital computer is the basic tool for analysis and simulation of the system and its environment.
Author

N67-20196# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
A METHOD OF SYNTHESIZING MULTITERMINAL SWITCHING CIRCUITS USING ONLY GENERALIZED NUMERATION
Rei-chi Song 16 Sep. 1966 9 p refs Transl. into ENGLISH from Tzu Tung Hua Hsueh Pao (Communist China), v. 3, no. 1, 1965 p 41–44
(FTD-TT-65-1854; TT-67-60258; AD-643732) CFSTI: HC $3.00/MF $0.65

Translation of Chinese research. A method of synthesizing multiterminal switching circuits using only generalized numeration.
TAB

N67-20267*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
RLC SYNTHESIS OF TRANSFER FUNCTIONS
James W. Fontanot and Don H. Townsend *In its* Aero-Astrodyn. Res. Rev. No. 5 15 Oct. 1966 p 70–79 refs (See N67-20261 09-34)

This paper presents a method and a digital computer program for Resistance-Inductance-Capacitance (RLC) synthesis of minimum-phase transfer functions. The method realizes the network in ladder form with a resistance termination. Every inductor has an associated series resistance. All realizations are within a constant multiplier, provided that no poles occur on the $j\omega$-axis, including infinity. Complex curve-fitting techniques are used for determining if there is a lower-order transfer function, H(s), which satisfies the requirements used to arrive at the transfer function to be synthesized. The synthesis problem can always be reduced to synthesizing driving-point functions of the complexity no greater than the ratio of fourth-order polynomials in s. Sensitivity studies are possible by a computer program from which the frequency response of the network can be determined. Numerical examples are given, and frequency response curves are compared with ideal curves to illustrate that the desired transfer response is obtained.
Author

N67-20268*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
A SIMPLE FEEDBACK LAW FOR A COOPERATIVE RENDEZVOUS PROBLEM

Thomas E. Carter *In its* Aero-Astrodyn. Res. Rev. No. 5 15 Oct. 1966 p 80–83 refs (See N67-20261 09-34)

A cooperative rendezvous problem for two point masses sufficiently near each other that the accelerations caused by external forces are the same for both objects provides a simple example of a linear regulator problem in which the steady-state solution of the associated matrix-Riccati equation can easily be found. A simple linear feedback law with constant coefficients follows. Author

N67-20269*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

CALCULATION OF CONTROL GAINS WITH FILTERS FOR RIGID BODY MOTION OF A SPACE VEHICLE

William H. Beutjer *In its* Aero-Astrodyn. Res. Rev. No. 5 15 Oct. 1966 p 84–94 ref (See N67-20261 09-34)

The equations for calculating the control gains with filters for the rigid body motion of a space vehicle are derived. The control gains can be calculated for the drift-minimum condition and for conditions close to drift-minimum. A computer program, written to calculate the control gains for attitude control, accelerometer control, or angle-of-attack control, shows the effect of varying the location of the accelerometer, the damping, and the control frequency. The system considered for this analysis is the Saturn S04 vehicle. A comparative study of the control gains was made without filters and for a body-fixed accelerometer using two different filter configurations. The results are given in the form of plots of g_2 versus a_0, and g_2 versus a_1. Also included are plots which show how the control gains vary with frequency and time. Author

N67-20351# Royal Aircraft Establishment, Farnborough (England).

THE STABILITY OF CONTROL SYSTEMS WITH TWO CONTROL DEVICES

A. M. Letov Dec. 1966 20 p refs Transl. into ENGLISH from Prikl. Mat. i Mekh. (Moscow), no. 27, 1953 p 401–410 (RAE-LIB-TRANS-1200) CFSTI: HC $3.00/MF $0.65

A method is presented for constructing Lyapunov functions for one Lur'e's method which was developed earlier for control systems with one control device. Author

N67-20356# Royal Aircraft Establishment, Farnborough (England).

CONCERNING THE STABILITY ANALYSIS OF MULTIPLE CONTROL SYSTEMS [EINE BEMERKUNG ZUR STABILITATSANALYSE VON MEHRFACHREGELUNGEN]

G. E. Knausenberger Nov. 1966 36 p refs Transl. into ENGLISH from Z. Flugwiss. (Brunswick, W. Germany), no. 14, 1966 p 41–49 (RAE-LIB-TRANS-1187) CFSTI: HC $3.00/MF $0.65

The condition that the symmetrical parts of the matrices of the general oscillation equation $AX+BX+CX=0$ should be positive definite describes the regions of stability only insufficiently. Two possibilities of an extension are discussed. The first is the use of compound determinants composed of rows of several determinants in all possible combinations. Such determinants, together with the determinants of the matrices A,B,C form the coefficients of the characteristic equation. As a necessary condition for stability the sum of certain compound determinants must be positive. The second is an application of a quadratic form, representing the energy in the oscillation system, where also compound matrices are considered. These matrices are combinatorially composed of rows of several matrices. To test for stability use is made of a specific relation which connects an asymmetric determinant with its symmetric part and permits one to recognize when the quadratic form becomes negative. Matrices up to fourth order and examples of second order are discussed. A possible treatment of the oscillation equation, when its matrices contain skew symmetric parts, is mentioned and the application of the concept of a positive matrix is suggested. Author

N67-20375* Alabama Univ., University.

DESCRIBING FUNCTION ANALYSIS OF CONTROL SYSTEMS CONTAINING MULTIPLE NONLINEARITES

R. E. Lueg and V. S. Sohoni 1967 93 p refs (Grant NsG-381) (NASA-CR-82985) CFSTI: $3.00 CSCL 09C

The analysis of nonlinear control system by describing function techniques is considered, and details are given on the derivation of describing functions for multiple nonlinearities. The describing functions which are both amplitude and frequency dependent, are associated with the multiple nonlinearities in which there are one or more energy-storage units together with a nonlinear characteristic that is related to the energy-storage property in such a way that a mathematical separation into distinct linear and nonlinear parts is not feasible. The technique outlined here for obtaining the describing functions can be used in computing the describing functions for any other nonlinear combinations. A method was developed to take care of the amplitude dependency of the describing function family of the multiple nonlinearity containing a hysteresis relay. Several methods to find the transient response and the closed loop frequency response from the describing function data are outlined. Sample problems are also presented indicating the use of the derived describing functions, and the results are compared with the actual analog computer simulations of these problems. Author

11 FACILITIES, RESEARCH AND SUPPORT

Includes airports; lunar and planetary bases including associated vehicles; ground support systems; related logistics; simulators; test facilities (e.g., rocket engine test stands, shock tubes, and wind tunnels); test ranges; and tracking stations.

N67-19372# Israel Program for Scientific Translations, Ltd., Jerusalem.

A HIGH-VOLTAGE TRIELECTRODE ELECTRON GUN

K. P. Rybas and A. T. Ermolaev *In its* Elec. Instrumentation in High-Energy Phys., Collection of Papers No. 1 1966 p 110–117 refs (See N67-19361 09-23) CFSTI: HC $3.00/MF $0.65

The effect on beam focusing and other gun parameters of a cathode placed along the axis of an electron gun with Pierce optics, and trielectrode electron gun design based on the Pierce gun are discussed. The Pierce gun was studied under conditions of pulsed operation (5 sec duration with repetition frequency of 50 pulses/sec) at voltages of 20 and 80 kV, and the beam characteristics are graphed. A description is given of the trielectrode gun, for pulsed operation at 80 kV with beam currents of up to 5 amp, in which it is possible to alter the beam current without affecting the angle of divergence and beam energy. It is pointed out that the gun is completely demountable, and that the electron beam optics gives best results for the following electrode distances: cathode–first anode, 32 mm; first anode–second anode, 20 mm. N.E.N.

N67-19373# Israel Program for Scientific Translations, Ltd., Jerusalem.

A HIGH-FREQUENCY ION SOURCE FOR DIRECT ACTION ACCELERATORS

L. I. Ivanova and A. I. Solnyshkov *In its* Elec. Instrumentation in High-Energy Phys., Collection of Papers No. 1 1966 p 118–122 refs (See N67-19361 09-23) CFSTI: HC $3.00/MF $0.65

An ion source design for electrostatic and neutron generators is described which provides compactness, simplicity and reliability

of construction, low supply power, and small gas discharge. The source was checked in a scale model of a 2 MeV electrostatic generator. Measurements showed that the source gave a 100 to 400 μamp ion beam for a gas flow of 1 to 2 cm^3/hr. Experiment indicated that the inductance method of excitation is more efficient than the capacitance method. The ion–optical system design assured focusing in the accelerating tubes with a small electrode aperture of 20 to 39 mm. Mechanisms of discharge excitation are mentioned.
N.E.N.

N67-19374# Israel Program for Scientific Translations, Ltd., Jerusalem.
MEASUREMENT OF BELT TENSILE STRENGTH IN ELECTROSTATIC GENERATORS
G. Ya. Roshal' and A. L. Fedulov *In its* Elec. Instrumentation in High-Energy Phys., Collection of Papers No. 1 1966 p 123–124 (See N67-19361 09-23) CFSTI: HC $3.00/MF $0.65

An instrument for the determination of the belt's tensile strength by strain measurement is briefly described. The tensile stress is communicated from the stretching mechanism to the conveyor belt by an intermediate link consisting of two bronze laminas to which 20μ constantan wire strain gauges are bonded. When the belt is stretched, the laminas are also stretched and the resistance of the sensing elements is altered and recorded.
N.E.N.

N67-19379# Israel Program for Scientific Translations, Ltd., Jerusalem.
VACUUM CHAMBERS OF STRONG-FOCUSING SYNCHROTRONS
I. F. Malyshev, A. V. Popkovich, P. A. Fefelov, and Yu. A. Sokolov *In its* Elec. Instrumentation in High-Energy Phys., Collection of Papers No. 1 1966 p 160–169 refs (See N67-19361 09-23) CFSTI: HC $3.00/MF $0.65

The requirements and designs for accelerator vacuum chambers are reviewed. The chamber materials and thickness, the effects of pressure difference on inside and outside of walls, and the effects of particle bombardment are considered. Details are presented on chamber designs for the 7 BeV proton synchrotron and for the 6 BeV electron synchrotron.
N.E.N.

N67-19407# Toronto Univ. (Ontario).
ENERGY CONVERSION
In its Ann. Progr. Rept., 1966 Oct. 1966 p 39–42 (See N67-19403 09-34)

Assembly of a graphite inert gas heater for use in energy conversion studies is related, and difficulties encountered during assembly are described. The planned power generation channel is to be a 5 cm × 10 cm channel with uncooled alumina walls. Fairly extensive changes were made to design for the dc electromagnet. The major change was from H-laminations to C-laminations in order to provide better facilities for optical studies of the flowing plasma. The iron pole faces were also changed from 6 × 6 in. to 6 × 8 in. gap to allow for divergent channels. Brief mention is made to a water-cooled downstream heat exchanger and plasma spectroscopy studies.
S.P.

N67-19450# Oak Ridge National Lab., Tenn.
SUPPORT FOR THE HIGH-VOLTAGE ACCELERATOR PROGRAM
In its Instrumentation and Control Div. Ann. Progr. Rept., for Period Ending Sep. 1965 Aug. 1966 p 159–163 refs (See N67-19423 09-14) CFSTI: HC $3.00/MF $0.65

Summary technical details on design, development, and installations in support of the high-voltage accelerator program are reported. Progress is recorded in the following areas: vacuum techniques in the high-voltage accelerator, new control console for the 5MV Van deGraaff accelerator, general-purpose scattering chamber for gaseous targets, duoplasmatron arc-current regulator, energy calibration system and pulsing equipment for the Tandem Van deGraaff accelerator. Transparencies as high as 84% were obtained in focusing elements of gridded ion lenses.
R.L.I.

N67-19527# California Univ., Berkeley. Lawrence Radiation Lab.
FURTHER IMPROVEMENTS ON THE 10-KV ION ACCELERATOR
Helmut M. Pohlit and Wallace R. Erwin *In its* Chem. Biodyn. Ann. Report, 1965 Mar. 1966 p 58–59 ref (See N67-19521 09-04)

The relationship between arc conditions and filament lifetime is discussed with reference to the changing of the ac filament power supply to a dc supply with a ripple of less than 0.15 V ptp. A modification to correct the problem of arc-disrupting discharges is described, and the effects of extraction voltage and admixtures of other gases with CO_2 on ion production efficiency are considered.
A.G.O.

N67-19715# Allis-Chalmers Mfg. Co., Milwaukee, Wis. Space and Defense Sciences Dept.
INSTRUCTION MANUAL FOR A HYDROGEN GENERATOR, VOLUME II
Sep. 1966 19 p
(Contract DA-44-009-AMC-1098(T))
(ACSDS-096640, Vol. II; AD-642141) CFSTI: HC $3.00/MF $0.65

The Hydrogen Generator consists of three major components: the liquid ammonia feed tank, the cracker coil assembly, and the hydrogen purifier. The delivery rate of the ultra-pure hydrogen product is infinitely variable up to 140 SCFH at 3 psig, with liquid ammonia input at 240 psig. The principle of the operation of the Hydrogen Generator is that gaseous ammonia feeding to the burner initially heats the cracker coils. Liquid ammonia is then pumped to the pre-heater (hydrogen product cooler) where it is vaporized, and then passes through the hot cracking coils where it dissociates into hydrogen and nitrogen. Pure hydrogen is forced through the diffuser on demand, while hydrogen-depleted gas is returned to the burner. By proper control, the burner is run on depleted gas alone at all levels of hydrogen demand. Thus, once operating, the system functions solely on liquid ammonia.
Author (TAB)

N67-19756# Frankford Arsenal, Philadelphia, Pa.
IMPROVEMENT OF LOW TEMPERATURE ENVIRONMENTAL TESTING CRITERIA AND PROCEDURES, PART I
Sylvan D. Rolle Jun. 1966 32 p refs
(M-67-5-1, Pt. 1; AD-642572) CFSTI: HC $3.00/MF $0.65

The report presents a new approach to the development of extreme low temperature environmental test criteria and procedures based on consideration of the interaction between the material and its environment which results in degradation of the reliability of the materiel. It proposes that each item of military materiel have, as part of its identification, its reliability in each of various Polar and Arctic environments. To facilitate this, a scale is proposed for rating the severity of low temperature environments. The program plans development of a usable scale of environmental severity, development of means for measuring values of this parameter, methods for correlating the effects of laboratory and of natural environments, and other activities needed to transform the proposed new environmental criteria into convenient form.
Author (TAB)

N67-19803# Naval Ordnance Lab., White Oak, Md.
THE NOL 3 MEGAWATT ARC TUNNEL Final Report
E. M. Winkler, R. L. Humphrey, M. I. Schlesinger, G. E. Baum, L. Kaplan et al 1 Sep. 1966 87 p refs
(NOL-TR-66-80; AD-644509)

The construction and installation of the tunnel was completed. The report describes in detail the mechanical, electrical, and instrumentation features of the tunnel. Emphasis is placed on those aspects that are unique for a true temperature hypersonic wind tunnel installation. Special data acquisition instrumentation is described. The tunnel operational regime covers Mach numbers from 4.5 to 11 at supply air pressures from 10 to 68 atmospheres and stagnation temperatures from 2000 to 6000K. Unit Reynolds numbers range from 3000 to 2,000,000 per foot. Results of tunnel shakedown and limited calibration tests are discussed. It was found that all components perform quite well and that tunnel conditions are reproducible with good accuracy. Author (TAB)

N67-19898* Chrysler Corp., Detroit, Mich.
A STATISTICAL TECHNIQUE FOR THE DYNAMIC ANALYSIS OF VEHICLES TRAVERSING ROUGH YIELDING AND NON-YIELDING SURFACES
B. D. Van Deusen Mar. 1967 191 p refs
(Contract NASw-1287)
(NASA-CR-659) CFSTI: $3.00 CSCL 13F

A technique has been developed which allows prediction and analysis of the dynamic response of vehicles traversing yielding and non-yielding rough surfaces. Virgin terrestrial and extraterrestrial surfaces are classified according to their frequency and amplitude distribution. A single parameter has been defined which, when properly interpreted, is sufficient to completely specify their surface roughness. This classification determines the nature of a random input to an analog computer simulation of the vehicle and surface dynamic models. Parametric model analysis can then be performed with the output criteria specified statistically. In addition, deterministic inputs can be used, and a simplified linear model technique is presented using transfer function concepts. Author

N67-19952* Goodrich (B. F.) Co., Shelton, Conn. Microwave Dept.
MEASUREMENT OF THE B. F. GOODRICH TAPERED CHAMBER AT THE MARSHALL SPACE FLIGHT CENTER
30 Jun. 1965 73 p refs
(Contract NAS8-13125)
(NASA-CR-82947; MR-27) CFSTI: $3.00 CSCL 14B

Design, construction, and shielding of the 120-foot-long anechoic facility are described as well as materials that were used in the structure. Measured data indicate that the chamber provides 1 db or better accuracy to the 40 down level on patterns at S-band and above, and this same accuracy to the 20 db down level on patterns to a frequency as low as 200 MHz. The chamber will be useful for certain purposes down to at least 60 MHz. K.W.

N67-19995* National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach Fla.
PROJECT DEVELOPMENT PLAN FOR LAUNCH INSTRUMENTATION
6 Jun. 1966 80 p refs
(NASA-TM-X-59474) CFSTI: $3.00 CSCL 22D

This development plan describes the launch instrumentation systems being developed and implemented for the Kennedy Space Center. The instrumentation on board the flight vehicle and checkout equipment related directly thereto are not a part of launch instrumentation. The specific instrumentation systems and services provided by this organization of the ground operational support system are described briefly and illustrated with block diagrams. History, current status, and plans for the systems are briefly stated. A cross-reference to the system is provided by discussing the instrumentation facilities. Systems milestones, manpower, and funding schedules in the official OMSF format are included. Author

N67-20002# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
A DEVICE FOR BREAKING THE DIAPHRAGM OF A GAS-DYNAMICAL SHOCK TUBE
V. D. Mikhalevskiy and G. P. Startsev 2 Sep. 1966 5 p Transl. into ENGLISH from Soviet Patent no. 165920 (Appl. no. 857348/26-10, 16 Sep. 1963) 2 p
(FTD-HT-66-85; AD-643698) CFSTI: HC $3.00/MF $0.65

The object of the invention is a device for breaking the diaphragm of a gas-dynamical shock tube, which is the mechanism of destruction of the diaphragm, is different in that, to simplify the design and obtain high reproducibility of the rupture pressure of unpolished diaphragms, the mechanism of destruction is made in the form of knives placed directly behind the diaphragm in the transverse cross section of the tube perpendicular to one another and forming a wedge-shaped edge at their point of intersection. Author (TAB)

N67-20147# Stanford Univ., Calif. Linear Accelerator Center.
REPORT ON THE STANFORD LINEAR ACCELERATOR CENTER
G. A. Loew Oct. 1966 22 p Presented at 1966 Intern. Conf. on Instrumentation for High Energy Phys., Stanford, Calif., 9–10 Sep. 1966
(Contract AT(04-3)-515)
(SLAC-PUB-235; CONF-660918-8) CFSTI: HC $3.00/MF $0.65

A report is presented on the main features of SLAC, the main instrumentation along the accelerator and the beam switchyard and how they are tied together in two control rooms, and finally on the beam break-up phenomenon. NSA

N67-20150# California Univ., Berkeley. Lawrence Radiation Lab.
ROUND-TABLE DISCUSSION ON BUBBLE CHAMBERS
L. W. Alvarez 9 Sep. 1966 42 p ref Presented at the Data Anal. Sect. of the High Energy Phys. Instrumentation Conf., Stanford, Calif., 9–10 Sep. 1966
(Contract W-7405-ENG-48)
(UCRL-17096; CONF-660918-6) CFSTI: HC $3.00/MF $0.65

A study is presented on the data reduction of bubble chamber films from engineering and economic viewpoints. An attempt to determine a realistic value for the number of events per dollar is given for different scanning and measuring methods. NSA

N67-20153# Brookhaven National Lab., Upton, N. Y.
MEASUREMENT ON A MULTISTEM DRIFT TUBE STRUCTURE
S. Giordano and J. P. Hannwacker [1966] 23 p refs Presented at LASL Linear Accelerator Conf., Los Alamos, N. Mex., 10–13 Oct. 1966
(Contract AT(30-2)-GEN-16)
(BNL-10664; CONF-661021-5) CFSTI: HC $3.00/MF $0.65

A new standing wave structure, operating in the TM_{010} mode, for accelerating protons below an energy of 200 MeV is discussed. This structure employs more than one stem to support each drift tube, and unlike the conventional drift tube structure the stems play a significant role in shaping the dispersion curve about the operating TM_{010} mode. For the past year, an investigation into the detuning effects in linac cavities has been conducted at Brookhaven. The operating characteristics of a multistem structure are described in detail. Author (NSA)

N67-20155# Stanford Univ., Calif. Linear Accelerator Center.
SOME EFFECTS OF (NOT HAVING) COMPUTER CONTROL FOR THE STANFORD LINEAR ACCELERATOR
K. B. Mallory Oct. 1966 4 p refs Presented at LASL Linear Accelerator Conf., Los Alamos, N. Mex., 10–13 Oct. 1966
(Contract AT(04-3)-400)
(SLAC-PUB-221; CONF-661021-16) CFSTI: HC $3.00/MF $0.65

Amongst the original guidelines for the design of the control system for the Stanford linear accelerator was suitability for ultimate computer control of the accelerator. Although computer control has not materialized, this design influence has produced unusual features in the system. Video information was to be digested at the source and spoon-fed to the computer: the present system for bringing video signals to the central control room is very sketchy. Large special-purpose data recording systems were considered noncompetitive with a small computer: there is now no automatic data-recording system. Subsystems which are basically nothing but local switch-gear were to be fully implemented outside of central control: central control is only incidentally concerned with automatic phasing of the accelerator, personnel protection and beam shutoff interlock systems, and the automatic replacement of failed klystrons. Author (NSA)

N67-20201# Stanford Univ., Calif. Linear Accelerator Center.
MEASUREMENTS OF THE SLAC INJECTOR EMITTANCE
Roger H. Miller Oct. 1966 17 p refs Presented at the 1966 Linear Accelerator Conf., Los Alamos, N. Mex., Oct. 1966
(Contract AT(04-3)-400)
(SLAC-PUB-223; CONF-661021-17) CFSTI: HC$3.00/MF$0.65

The six-dimensional volume in phase space enclosing the beam from the SLAC injector was measured. The measurements reported for transverse and longitudinal phase volumes differ significantly from those used previously on the prototype injector. The method reported used a variable aperture plus glass plate (equivalent to a photographic film). The methods and results are compared for the prototype and final injectors. NSA

N67-20204# California Univ., Livermore. Lawrence Radiation Lab.
DECOUPLING TRANSFORMER FOR HIGH ENERGY PULSE SHAPING
K. Aaland and O. Zucker 18 Jul. 1966 31 p Presented at Symp. on Eng. Probl. of Controlled Thermonucl. Res., Gatlinburg, Tenn., 3–5 Oct. 1966 Submitted for publication
(Contract W-7405-ENG-48)
(UCRL-70011, Rev. 1; CONF-661016-18) CFSTI: HC $3.00/MF $0.65

A unique saturating pulse transformer was designed which, when inserted between a capacitor bank and an inductive load, will produce a trapezoidal current waveform resulting from the fact that transformer action actually ceases for a prescribed period of time once a desired level of current is attained. After a primary half-cycle ringing period, transformer action again resumes in the reverse direction, with the load current returning to zero. That development was described by K. Aaland in a paper entitled Saturating Pulse Transformer with Optimized Output for a Solenoid Load (UCRL 14511-T) which discusses the design of an actual transformer built. An analytical treatment of such a trapezoidal-pulse-producing transformer is presented. It begins by presenting some insight into the effect of saturation upon a ferromagnetic core. Then an assumption is made that there actually exists a transformer which will decouple upon saturation, whereupon, an analysis is made of a circuit utilizing such a transformer to couple a charged capacitor to an inductor, showing that the output current is one which would be desirable for many short duration, constant current requirements. Then the calculation of the parameters involved (i.e., capacitance, primary saturation inductance and the core volt-second product) for obtaining a specified output are made. Next, the explanation of the decoupling mechanism is presented. Finally, the steps taken in the design of an actual transformer specifying dimensions that will have the specific features arrived at previously is presented and an explanation of why a one-turn primary/secondary configuration for the transformer is used is shown, despite the fact that such a set-up necessitates the use of a very large, heavy iron core. A discussion of several refinements to the design is also included. Author (NSA)

N67-20210# Oak Ridge National Lab., Tenn.
MAGNET DEVELOPMENT FOR THE 50-MeV SOC
E. D. Hudson, R. S. Lord, J. E. Mann, and F. E. McDaniel [1966] 19 p refs Presented at the Symp. on Separated Orbit Cyclotrons and Beam Cavity Interactions, Weston-on-the-Green, England 6–8 Jul. 1966
(Contract W-7405-ENG-26)
(ORNL-P-2357, CONF-660720-1) CFSTI: HC$3.00/MF$0.65

A full-scale prototype sector magnet, which constitutes one sector of a proposed 12-sector 10–50 MeV SOC, was completed and preliminary tests were run to establish the magnet efficiency and magnet power for the system. NSA

N67-20252# Stanford Research Inst., Menlo Park, Calif.
IMPLOSIVELY DRIVEN SHOCK TUBES
Stephen P. Gill 15 Dec. 1966 28 p refs
(TR-001-66)

Various techniques are described for making effective and controlled use of the energy resources of chemical explosives in very high energy shock tubes. These implosive shock tubes provide an energy capability several orders of magnitude greater than conventional shock tubes, and in addition have a number of unique advantages for research in high energy gasdynamics. Diagnostic experiments described here indicate exceptional flow quality and duration for shock velocities ranging from 7 to 30 km/sec and initial test gas pressures ranging from 500 microns to 20 atm. Author

N67-20258* Rucker Co., Oakland, Calif.
CONSTANT AZIMUTH CENTRIFUGE Final Report
[1966] 21 p
(Contract NAS8-11856)
(NASA-CR-82850) CFSTI: HC$3.00 CSCL 14B

Activities involved in the development and installation of a constant azimuth centrifuge system are reviewed, and each item of equipment is described. Equipment in the centrifuge system consisted of a bearing system, the main drive system, servo control, speed readout, azimuth table drive, a differential pressure gauge to indicate machine balance or unbalance, the shaker, and its amplifier and field supply unit, rotary joints, slip rings and the television camera. Also briefly mentioned are the systems for cooling water, vacuum, gas, and carbon dioxide. S.P.

N67-20279# Brookhaven National Lab., Upton, N. Y.
BUBBLE CHAMBER DATA PROCESSING DEVELOPMENTS
P. V. C. Hough Sep. 1966 55 p refs Presented at Intern. Conf. on Instrumentation for High Energy Phys., Stanford, Calif., 9–10 Sep. 1966
(Contract AT(30-2)-GEN-16)
(BNL-10673; CONF-660918-7) CFSTI: HC$3.00/MF$0.65

The major developments in bubble chamber data processing are discussed specifically in measuring systems, event identification, and bubble density measurements. NSA

N67-20295# European Space Research Organization, Paris (France).
THERMAL ENVIRONMENT SIMULATION
L. A. Husain (European Space Technol. Center, Noordwijk, Netherlands) Dec. 1966 27 p refs Presented at the ESRO Summer School, Oxford, 31 Aug. 1964
(ESRO-TM-50) CFSTI: HC$3.00/MF$0.65

The different types of thermal tests are gone into in some detail: soak tests, including environmental and thermal vacuum tests, which are directed towards establishing the general effects of temperature, humidity, etc., and solar simulation tests, which aim at assessing the effects of operation temperature distributions. The problems encountered in designing solar simulation tests are outlined. Finally the essential differences in the various concepts of space environment simulators are pointed out and illustrated by a comparison between the GEC Space Environment Simulator (SES) and the Goddard Space Flight Center SES. Author (ESRO)

12 FLUID MECHANICS

Includes boundary-layer flow; compressible flow; gas dynamics; hydrodynamics; and turbulence. For related information see also: 01 Aerodynamics; and 33 Thermodynamics and Combustion.

N67-19404# Toronto Univ. (Ontario).
MECHANICS OF RAREFIED GASES
In its Ann. Progr. Rept., 1966 Oct. 1966 p 4–6 (See N67-19403 09-34)

Theoretical work on the free-molecular transport properties associated with internal flow through axisymmetric tubes by using general wall reflection laws is reported. A brief summary is presented for study of free-molecule transfer of mass, axial momentum, and energy through axially symmetric tubes. An electron beam probe was used to obtain measurements of rotational temperature and gas density in supersonic nitrogen jets expanding from room temperature. An electron beam was used to study the diffusive separation of helium–argon mixture in free jets and shocks. Finally, the shock wave structure in weakly ionized plasmas with elevated temperatures was examined. S.P.

N67-19406# Toronto Univ. (Ontario).
HYPERSONIC GASDYNAMICS AND BLAST WAVE PHENOMENA
In its Ann. Progr. Rept., 1966 Oct. 1966 p 19–38 refs (See N67-19403 09-34)

Efforts were concentrated mainly on an implosion-driven hypervelocity launcher and on studies of nonequilibrium flows of dissociated oxygen and ionized argon. The possibility of generating stable centered implosions by initiating hemispherical shells of safe secondary explosive with gaseous detonation waves is demonstrated. Work was initiated on a second generation implosion-driven launcher capable of launching one-inch diameter projectiles in the planetary reentry hypervelocity regime. Some analytical back-up work on properties of hydrogen–oxygen detonations at high pressure was verified in the launcher chamber up to initial pressures of 500 psi. Use of combinations of catalytic and noncatalytic differential heat transfer probes proved successful not only in measuring the local oxygen atom concentration in hypersonic free-stream but also in simultaneously measuring the gauge catalytic efficiency. Interferometric measurements of both atomic and molecular oxygen Gladstone–Dale constants was made to accuracies of one to two percent. Interferometric investigation of dissociated oxygen flows around corners showed the desirability of measuring simultaneously more sensitive quantities such as atom concentration and temperature to study wave structure and recombination rate constants. S.P.

N67-19413# Toronto Univ. (Ontario).
MOLECULAR BEAMS AND SURFACE INTERACTIONS
In its Ann. Progr. Rept., 1966 Oct. 1966 p 75–82 refs (See N67-19403 09-34)

Theoretical and experimental studies were conducted on the reflection process of gas molecules at a satellite surface in extreme altitudes. Molecular beams of high intensity and high velocity were developed to simulate the molecular kinetic energies corresponding to satellite flight. Then the molecules in the beam were scattered from carefully prepared monocrystalline surfaces inside ultrahigh vacuum test chambers equipped with ancillary systems to monitor the amount of gas adsorbed on the surfaces being tested. Equipment to study overall momentum exchange and reflected molecular flux distributions was assembled. Another project to develop a time-of-flight velocity analyzer using metastable molecules was conducted. Finally efforts focused on a theoretical model of gas-surface interactions at satellite velocities. S.P.

N67-19421# Aeronautical Research Council (Gt. Brit.)
A UNIFIED THEORY OF FRICTION, HEAT TRANSFER AND MASS TRANSFER IN THE TURBULENT BOUNDARY LAYER AND WALL JET
D. B. Spalding (Imperial Coll. of Sci. and Technol.) London, HMSO, 1965 130 p refs Supersedes ARC-25925; see X65-10956 (ARC-CP-829; ARC-25925; AD-479319) HMSO: 15s

General equations are derived for the conservation of mass, momentum and other properties and their solutions are derived using three parameter profiles and an hypothesis concerning entrainment from the mainstream into the boundary layer. Discussed is the applicability of the proposed approach to the following plane uniform property flows along smooth walls: the impermeable flat plate; the impermeable wall in the presence of an adverse pressure gradient; the flat plate with mass transfer; the wall jet in stagnant surroundings; and heat transfer in the absence of mass transfer. The assumptions appear sufficiently realistic and flexible to provide a simple single calculation method for the cited processes even when these operate simultaneously and in conjunction with roughness, three-dimensional flow reversal, and variable-property effects. The main barrier to further progress is the manner in which entrainment is influenced by density variations. Author

N67-19457# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.
NUMERICAL CALCULATION OF THE TURBULENT MIXING OF TWO UNIFORM GAS FLOWS
P. P. Koryavov 22 Sep. 1966 29 p refs Transl. into ENGLISH from Zh. Vychislitel'noi Mat. i Mat. Fiz. (Moscow), v. 4, no. 3, 1964 p 495–511
(Contract NOw-62-0604-c)
(TG-230-T501; TT-66-62474; AD-640611) CFSTI: HC $3.00/MF $0.65

On the basis of the approximate boundary-layer theory an investigation is made of the problem of turbulent mixing of two uniform flows of a compressible fluid for Prandtl numbers different from one with particular attention to the temperatures and velocities of the mixing flows. The equations of turbulent mixing are reduced to the equations of laminar mixing using some new independent variables. It is shown that introduction of these new variables permits separation of the boundary-value problem for flow in the mixing zone, which involves certain mathematical difficulties, from that of calculating temperature and velocity profiles for actual cross sections, which is not difficult mathematically but requires the use of empirical quantities. Author (TAB)

N67-19482 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
FLOW AROUND BODIES OF STEPPED FORM AT A SMALL ANGLE OF ATTACK BY A HYPERSONIC FLOW OF GAS
V. I. Kholyavko *In its* Aviation Eng., Vol. 7, No. 3 28 Sep. 1966 p 1–8 refs (See N67-19481 09-34) CFSTI: HC $3.00

An analogy to nonstationary flows and an integration procedure are used to solve the equations of flow around flat bodies of stepped form that are located at a small angle of attack in the flow of a nonviscous ideal gas. The approximate solution is in the form of a power series with respect to the angle of attack; and aerodynamic properties are determined for bodies with pointed or blunt noses. These equations for determining the influence of form and blunting of leading edge around an airfoil are considered valid for slender bodies. M.W.R.

N67-19488 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
CALCULATION OF LOSSES UPON SUDDEN EXPANSION OF FLOW
A. Ye. Zaryankin and L. V. Mikhnenkov *In its* Aviation Eng., Vol. 7, No. 3 28 Sep. 1966 p 53–61 refs (See N67-19481 09-34) CFSTI: HC $3.00

Errors that might occur in the calculation of losses in conical diffusers or cylindrical channels following a sudden expansion of flow are treated, and the applicability of two different formulas is considered. Specific applications to turbines are discussed, and the variation of pressure recovery factor as a function of degree of expansion is shown. M.W.R.

N67-19580# Wigley (C.), London (England).
THE EFFECT OF FLUID VISCOSITY ON WAVE RESISTANCE USING A MODIFICATION OF LAURENTIEFF'S METHOD—A MORE ACCURATE CALCULATION
C. Wigley May 1966 49 p refs
(Contract N62558-4526)
(AD-640633) CFSTI: HC$3.00/MF$0.65

A new calculation was made at four speeds for the same form of hull as in an earlier report, but to a much higher degree of accuracy. This calculation is described, and its results are given. Author (TAB)

N67-19727# Brown Univ., Providence, R. I. Div. of Applied Mathematics.
LINEARIZED FLOW IN ROTATING SYSTEMS
Frederic E. Bisshopp Sep. 1966 45 p refs
(Contract Nonr-562(42))
(TR-2; AD-642578) CFSTI: HC$3.00/MF$0.65

The linearized equations governing incompressible, viscous flow which deviates slightly from rapid uniform rotation are treated in a boundary layer approximation. For a number of problems in which the flow is confined to the region between horizontal plates, representations of the solutions, valid everywhere but in vanishingly small corners, are given. Cases where a rigid side wall moves at a velocity which differs from one or both of the plate velocities are treated by means of an integral transform which has many features in common with a Fourier sine-transform. A heuristic derivation of the inversion theorem is given. Author (TAB)

N67-19749# Minnesota Univ., Mineapolis. St. Anthony Falls Hydraulic Lab.
EXPERIMENTAL INVESTIGATION OF TAYLOR INSTABILITY USING NON-NEWTONIAN FLUIDS Final Report
C. S. Song and F. Y. Tsai Jun. 1966 38 p refs *Its* Proj. Rept.-84
(Contract Nonr-710(62))
(AD-642847) CFSTI: HC$3.00/MF$0.65

The critical Taylor numbers for five different non-Newtonian solutions were determined experimentally by visual observation using the hydrogen bubble technique. Contrary to a finding by others, the present experiment indicates that the critical Taylor number is decreased as the concentration is increased. The shear on the outer cylinder due to rotation of the inner cylinder was also measured for an intermediate range of Reynolds number. Substantial reductions of frictional drag coefficient were achieved at higher additive concentrations when the comparison was based on equal Reynolds number. Author (TAB)

N67-19764# Naval Ordnance Lab., White Oak, Md.
AN EXPERIMENTAL STUDY OF THE TURBULENT WAKE BEHIND A CONE AT MACH 5
William C. Ragsdale and John A. Darling 27 Sep. 1966 139 p refs *Its* Aerodyn. Res. Rept.-262
(NOLTR-66-95; AD-643196) CFSTI: HC$3.00/MF$0.65

An experimental study of the turbulent wake behind a 9 degree adiabatic cone at Mach 5 was carried out. Cone models with base diameters of 2 inches and 4 inches were mounted in the wind tunnel test section with fine wires. Pitot pressure, pressure on a small cone probe and total temperature were measured with probes mounted on a vertical traversing mechanism. The measured pressures and temperatures were used to calculate the Mach number, static pressure, static temperature, velocity and density in the wake. Author (TAB)

N67-19886*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
EXPERIMENTAL INVESTIGATION OF THE TURBULENT BOUNDARY LAYER AT A MACH NUMBER OF 6 WITH HEAT TRANSFER AT HIGH REYNOLDS NUMBERS
Richard D. Samuels, John B. Peterson, Jr., and Jerry B. Adcock Washington, NASA, Mar. 1967 75 p refs
(NASA-TN-D-3858) CFSTI: HC$3.00/MF$0.65 CSCL 01A

An experimental investigation of turbulent boundary-layer skin friction and heat transfer on a hollow cylinder was made at a Mach number of 6 and with two wall temperatures at Reynolds numbers based on distance from the virtual origin from 2.4×10^6 to 28.7×10^6. Data obtained include total-temperature profiles, velocity profiles, average skin-friction coefficients obtained by the momentum method, and Stanton numbers obtained from use of heat flowmeters. The measured temperatures in the boundary layer were compared with two theoretical distributions, the Crocco laminar distribution used by Van Driest and a quadratic distribution used by Donaldson. The skin-friction coefficients were compared with the theories of Van Driest, Monaghan and Johnson, Sommer and Short, and Spalding and Chi. Stanton numbers were also compared with these theories in conjunction with the Colburn modification of Reynolds analogy. Experimental results indicate that at high Reynolds numbers wall-temperature ratio has no appreciable effect on the average skin-friction coefficient. At high Reynolds numbers, the theory of Spalding and Chi gave fair agreement with the experimental data. However, the Colburn modification of Reynolds analogy along with the turbulent skin-friction theory of Spalding and Chi underestimates the measured heat-transfer coefficient. Author

N67-19887*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
EFFECT OF ROUGHNESS ON HEAT TRANSFER TO HEMISPHERE CYLINDERS AT MACH NUMBERS 10.4 AND 11.4
James C. Dunavant and Howard W. Stone Washington, NASA, Mar. 1967 40 p refs
(NASA-TN-D-3871) CFSTI: HC$3.00/MF$0.65 CSCL 20M

Heat-transfer and pressure distributions on hemisphere-cylinder models have been presented at nominal Mach numbers of 10 and 11 over a free-stream Reynolds number range of 0.77×10^6/m to 7.4×10^6/m (0.23×10^6/ft to 2.2×10^6/ft). The 0.15-m (6.0-in.) diameter models had round-protuberance roughened surfaces with heights of 0.63 mm and 1.26 mm (0.025 in. and 0.050 in.), a random nodular roughened surface with an average height of 0.1 mm (0.004 in.), and a reference smooth surface. The results indicate the roughness elements did not increase the heat transfer at the stagnation point, on the hemisphere, or on the cylinder when the flow remained laminar. At the higher Reynolds numbers, heating rates characteristic of transitional boundary layers were measured on the hemispherical part of several roughened models. On the cylindrical part of the model downstream of the transitional flow, heat rates equal to those of the smooth model were observed. The calculated momentum thickness Reynolds numbers at transition were very low between 25 and 55. Author

N67-19888*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
EFFECTIVENESS OF FLEXIBLE AND RIGID RING BAFFLES FOR DAMPING LIQUID OSCILLATIONS IN LARGE-SCALE CYLINDRICAL TANKS
David G. Stephens and Harland F. Scholl Washington, NASA, Mar. 1967 34 p refs
(NASA-TN-D-3878) CFSTI: HC$3.00/MF$0.65 CSCL 20D

An investigation was conducted to determine the effectiveness of lightweight, flexible baffles for damping liquid oscillations in relatively large cylindrical tanks. The free decay of the fundamental antisymmetric liquid mode was measured in 30- and 112-inch (76.2- and 284-cm) diameter rigid tanks fitted with both flexible and rigid annular ring baffles. Data are presented to illustrate the variation of liquid damping with slosh amplitude, baffle location, tank size, and baffle flexibility. Comparative flexible and rigid baffle damping results are presented in terms of nondimensional parameters which cover a wide range of liquid velocity and baffle flexibility conditions. In addition, measured slosh frequencies and rigid baffle damping coefficients are compared with available theory. Results indicate that slosh damping comparable to that provided by a rigid baffle can be obtained through the use of smaller, much less massive, flexible baffles. Author

N67-19890*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

BOUNDARY-LAYER MEASUREMENTS IN ACCELERATED FLOWS NEAR MACH 1

Howard L. Wesoky Washington, NASA, Mar. 1967 36 p refs
(NASA-TN-D-3882) CFSTI: HC $3.00/MF $0.65 CSCL 20D

Experimental velocity and temperature profiles for the adiabatic boundary layers on cylindrical bodies in parallel accelerated flows are presented. Measurements were made near Mach 1 with the accelerations imposed by two axisymmetric nozzles having large differences in pressure gradient. The effects of boundary-layer tripping and development length were examined. Velocity profiles compared on a power profile basis yielded values for the exponent in the range 1/2.1 to 1/11.0. Comparison of the velocity profiles to two forms for the "law of the wall" and the Deissler prediction method yielded good results when used with the Coles friction law. A significant effect of pressure history on friction coefficient was observed, which could be related to a nonadiabatic flow field through Reynolds analogy. The measured temperature profiles did not compare as well as the velocity profiles with the theories of Rotta or Deissler. The common assumption of constant boundary-layer total temperature for adiabatic flow was confirmed. Author

N67-19892* National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.

THE STAGNATION-POINT BOUNDARY LAYER WITH SUCTION AND INJECTION IN EQUILIBRIUM DISSOCIATING AIR

Kenneth C. Weston Washington, NASA, Mar. 1967 34 p refs
(NASA-TN-D-3889) CFSTI: $3.00 CSCL 01A

Calculations for the compressible, equilibrium dissociating stagnation-point boundary layer with suction and injection have been performed using a digital computer. Results are shown which reproduce both the perfect gas, the linear viscosity-temperature relation calculations of Cohen and Reshotko, and the dissociating-air results of Fay and Riddell. Calculations for the dissociated-air boundary layer with air injection indicate significantly higher heating rates than those obtained for the perfect gas, linear viscosity-temperature relation model. A procedure is indicated which allows application of the results for air injection to engineering calculations for cases of foreign-gas injection. Author

N67-19927* Georgia Inst. of Tech., Atlanta.

ANALYTICAL MECHANICAL MODEL FOR THE DESCRIPTION OF THE SLOSHING MOTION Final Report

Helmut F. Bauer, Jose Villanueva, and Shen Shu Chang 31 Dec. 1966 60 p refs
(Contract NAS8-20203)
(NASA-CR-82843) CFSTI: HC $3.00 CSCL 20D

Liquid forces and moments due to longitudinal excitation of a rigid circular cylindrical container were obtained from nonlinear liquid theory. Through the anti-symmetric one-half-subharmonic response of the liquid these forces and moments will influence the lateral stability of a space vehicle. A mechanical model describing this nonlinear liquid response has been derived and compared with liquid theory. The model consists of a mass with a moment of inertia which is rigidly connected to the container, and of independently oscillating masspoints capable of rolling on a guiding surface of paraboloidal form. Each of these masspoints is coupled with a nonlinear third order spring capable of moving up and down the longitudinal axis of the container. Author

N67-19936*# Case Inst. of Tech., Cleveland, Ohio. Engineering Div.

SIMILARITY SOLUTION OF A JET FLOWING OVER A CURVED SURFACE

Bruce G. Lindow and Isaac Greber Jun. 1966 45 p refs
(Grant NGR-36-3-064)
(NASA-CR-82933; FTAS/TR-66-15) CFSTI: HC $3.00/MF $0.65 CSCL 20D

The flow of a laminar two-dimensional incompressible jet flowing over a curved surface is analyzed for the case of small curvature. The zeroth order solution is the same as for a jet over a flat surface. Therefore, to find the effects of curvature on the jet, the first order solution is found. The first order solution is found by the use of a similarity transformation and a perturbation of the stream function. The use of a similarity transformation restricts the type of surface curvature that may be considered, so that the allowable surface shapes are also found. Author

N67-19968 Royal Aircraft Establishment, Farnborough (England).

AN EXPERIMENTAL METHOD FOR STUDYING THE HIGH SPEED IMPACT OF A LIQUID DROP ON A LIQUID SURFACE

D. C. Jenkins Apr. 1966 12 p refs
(RAE-TR-66135)

An experimental method for studying the high speed impact of a liquid drop on a liquid surface is described in which the liquid surface is moved against the stationary drop. Photographs are presented of the impact of a water surface at 47.7 m/sec on a stationary water drop 0.175 cm diameter. Proposals are made for further work to resolve certain discrepancies between results obtained using this method and those derived from earlier work in which drops fall freely onto a standing surface. Author

N67-19970# National Gas Turbine Establishment, Pyestock (England).

THE PRESSURE LOSS ASSOCIATED WITH COMPRESSIBLE FLOW THROUGH SQUARE-MESH WIRE GAUZES

R. A. Pinker and M. V. Herbert Jun. 1966 42 p refs
(NGTE-R-281)

Tests have been carried out on a selection of eight single gauzes placed normal to the axis of a duct, of sizes (wire diameter and mesh) such as might be commonly used to give values of porosity between 0.3 and 0.7. Pressure loss measurements were carefully made, and covered independently duct Mach numbers up to choking and a 50-fold range of Reynolds number. The test data are presented so as to provide a single relation between the incompressible loss factor and a form of Reynolds number, plus a compressibility correction which depends on gauze porosity. Author

N67-20007# New York Univ., N. Y. Dept. of Aeronautics and Astronautics.

AN INVESTIGATION OF THE VORTICITY INTERACTION BY PERTURBATION TECHNIQUES

Egon Krause Oct. 1966 57 p refs
(Contract Nonr-285(63))
(NYU-AA-66-84; AD-644026) CFSTI: HC $3.00/MF $0.65

The interaction between the boundary layer and the vortical layer on the aft portion of blunted bodies is investigated. It is assumed that the boundary layer thickness is much smaller than

that of the vortical layer so that the boundary conditions at the common boundary can be provided by asymptotic matching of the two layers. The zero- and first order solutions for the outer and inner layer are established by numerical integration. The flow equations for the boundary layer are solved by finite-difference integration, while the solution for the vortical layer is established by the method of characteristics. Author (TAB)

N67-20008# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
EXPERIMENTAL INVESTIGATION OF THE FORMATION OF A GAS JET BEHIND THE FRONT OF A SHOCK WAVE IN THE OUTFLOW OF DIVERGENT AND SUPERSONIC NOZZLES
A. I. Starshinov 14 Jul. 1966 8 p refs Transl. into ENGLISH from Vestn. Leningr. Univ., Ser. Mat., Mekh. I Astron. (Leningrad), no. 4, 1965 p 166–168
(FTD-HT-66-137; AD-644046) CFSTI: HC $3.00/MF $0.65

A shock tube was used in carrying out the investigations. Dimensions of the nozzles used in the experiment are given together with empirical formulas obtained. TAB

N67-20014# Politecnico di Torino (Italy). Istituto di Meccanica Applicata.
HIGHLY SIMPLIFIED CALCULATION OF THE INCOMPRESSIBLE LAMINAR BOUNDARY LAYER
Gianni Jarre Dec. 1965 20 p refs
(Grant AF-EOAR-63-98)
(AFOSR-66-2742; TN-35; SR-11; AD-644129) CFSTI: HC $3.00/MF $0.65

A highly simplified calculation of the incompressible laminar boundary layer under any variable pressure gradient, is outlined and satisfactorily applied to accelerated and retarded flows. The method allows to derive directly the shear stress at the wall from the outer velocity law. The method is very promising in the field of the aeronautical slender bodies. TAB

N67-20020# Boeing Scientific Research Labs., Seattle, Wash. Flight Sciences Lab.
THE TWO-DIMENSIONAL LAMINAR JET IN PARALLEL STREAMING FLOW
I. Wygnanski Jul. 1966 27 p refs *Its* Flight Sci. Lab. Rept.-107
(DI-82-0549; AD-637138) CFSTI: HC $3.00/MF $0.65

Solutions to the problem of a two-dimensional, laminar jet of incompressible fluid issuing into a uniform stream in the direction of the main flow are considered. Two coordinate-type expansions are developed. A direct expansion, when suitably transformed, predicts approximately the velocity along the plane of symmetry of the jet for all values of the abscissa, with a maximum error of 7.6% far downstream from the origin. This error is established by comparison with a second, asymptotic expansion valid only at large values of the abscissa. The two expansions are subsequently joined, permitting an approximate determination of a constant which multiplies a third order in the asymptotic series and which initially remained unknown even after satisfying all boundary conditions imposed on these series. The decay of velocity excess along the plane of symmetry of the jet is accelerated by the presence of the external stream. Author (TAB)

N67-20187# Princeton Univ., N. J. Gas Dynamics Lab.
AN EXPERIMENTAL MODEL FOR THE SHARP LEADING EDGE PROBLEM IN RAREFIED HYPERSONIC FLOW
William J. McCroskey Wright-Patterson AFB, Ohio, ARL, Jun. 1966 84 p refs
(Contract AF 33(615)-3328)
(ARL-66-0101; Rept.-771; AD-641998) CFSTI: HC $3.00/MF $0.65

Flow field studies of the shock wave and boundary layer development on a sharp flat plate are presented for a region of rarefied flow that bridges the gap between a classical hypersonic boundary layer downstream and a kinetic flow model at the leading edge. The measurements give a comprehensive picture of the flow pattern in the "merged layer" or "viscous layer" regime, which exists upstream of the region of validity of hypersonic viscous interaction theory. The results are derived from a combination of several probing and optical techniques and surface pressure measurements. From the detailed measurements, a true scale physical model of the flow field is constructed for the merged layer regime. One of the main features of the model is a thick, curved shock wave which decreases in strength as the leading edge is approached, even though the shock angle increases. Density profiles across the shock and viscous layers show that the structure of the flow field is quite different from the classical picture of a hypersonic boundary layer beneath an oblique Rankine-Hugoniot shock wave. Author

N67-20198# Massachusetts Inst. of Tech., Cambridge. Aeroelastic and Structures Research Lab.
A TIME-SHARED PROGRAM SYSTEM FOR THE SOLUTION OF THE STABILITY PROBLEM FOR PARALLEL FLOWS OVER RIGID OR FLEXIBLE SURFACES Interim Report
M. T. Landahl Oct. 1966 49 p refs
(Contract Nonr-1841(89))
(ASRL-116-4; AD-644162) CFSTI: HC $3.00/MF $0.65

The report describes a system of programs, designed to be used on the MIT Compatible Time Sharing System (CTSS), for solving the Orr-Sommerfeld parallel-flow stability problem of incompressible flow in contact with a rigid or flexible surface. The programs can be combined, building-block fashion, to treat a large variety of cases. As examples are shown: (1) Blasius boundary layer over a flexible membrane, (2) turbulent boundary layer over a free water surface, and (3) free shear layer. Author (TAB)

N67-20202# Comitato Nazionale per l'Energia Nucleare, Rome (Italy).
ITERATIVE METHODS FOR THE ANALOG SIMULATION OF PHYSICAL SYSTEMS CONTAINING FLOWING FLUIDS
A. Mathis, P. Giordano, and G. Gatto 1966 26 p refs Presented at the IFIP Congr. Meeting, New York, 1965
(RT-ING-(66)-1; CONF-650505-6) CFSTI: HC $3.00/MF $0.65

Several means of solving by iterative analog computation the partial differential equations describing systems containing flowing fluids are evaluated. The discretization of space and time variables by central and backward differences, are compared, with respect either to their possibilities in the simulation of physical systems, or to the errors involved. Author (NSA)

N67-20249* Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
INVESTIGATION OF SUPERSONIC SHOCK PHENOMENA IN A TWO-PHASE (LIQUID–GAS) TUNNEL
Robert B. Eddington 15 Mar. 1967 206 p refs
(Contract NAS7-100)
(NASA-CR-82860; JPL-TR-32-1096) CFSTI: $3.00 CSCL 20D

Results from operation of a supersonic two-phase tunnel indicate that all the shock phenomena, including normal, oblique, and conical shocks that are typical of single-phase supersonic gas flows, can be generated in supersonic two-phase gas-liquid continuum-type flows. Auxiliary flow devices were constructed for measurement of flow parameters such as the relative phase velocity, local void ratio, coefficient of friction, and stagnation pressure. A general change in the flow model matrix was found at volume ratios approaching 1:1. Pressure gradients and relative phase velocities were correlated with the proposed flow models with generally good agreement. The coefficient of friction measured for supersonic flow was found to be a simple function of the local void ratio. Stagnation pressures measured for a wide range of flow conditions approximated an isentropic relation for a substantial

part of the lower velocity spectrum. At higher velocities, the stagnation pressure closely approached the normal shock plus isentropic slowdown theory. Photographic information pertaining to shock structure and phase movement was obtained over the spectrum of flow conditions with Mach numbers ranging from 2 to 20. S.P.

N67-20301# Aeronautical Research Council (Gt. Brit.).
BULK COMPRESSIBILITY EFFECTS IN THE R.A.R.D.E. NO. 3 HYPERSONIC GUN TUNNEL
W. A. Clayden London, HMSO, May 1965 13 p refs Supersedes ARC-26972; RARDE-MEMO-21/65
(ARC-CP-882; ARC-26972; RARDE-MEMO-21/65) CFSTI: HC $3.00/MF $0.65

A procedure, based on existing methods and real gas tables, for estimating flow conditions in the working section of the hypersonic gun tunnel is outlined which includes the effects of bulk compressibility. It is also shown how bulk compressibility effects will modify the performance of the tunnel. Author

N67-20317# Gt. Brit. Ministry of Aviation, London. Technical Information and Library Services.
EXPERIMENTAL INVESTIGATION OF SURFACE FRICTION ON A PLANE PLATE IN A SUPERSONIC FLOW IN THE PRESENCE OF HEAT EXCHANGE [EKSPERIMENTAL'NOE ISSLEDOVANIE POVERKHNOSTNOGO TRENIYA NA PLOSKOI PLASTINE V SVERKHZVUKOVOM POTOKE PRI NALICHII TEPLOOBMENA]
L. V. Koslov Dec. 1966 13 p refs Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Otd. Tekhn. Nauk: Mekhan. i Mashinostr. (Moscow), v. 2, 1963 p 11–19
(TIL/T-5634) CFSTI: HC $3.00/MF $0.65

The local value of the surface friction is investigated, with heat exchange between flow and wall. An interpolation formula is obtained as a power function for calculating the friction for turbulent conditions over a wide range of Reynolds and Mach numbers and temperature drops. Author

N67-20339# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
NUMERICAL SOLUTION OF SOME PROBLEMS OF GAS FLOW
P. I. Chushkin 16 Sep. 1966 31 p refs Transl. into ENGLISH from Arch. Mech. Stosowanej (Poland), v. 16, No. 3, 1964 p 577–596
(FTD-TT-65-1826; AD-643895) CFSTI: HC $3.00/MF $0.65

A description is given of the numerical calculation of the potential flow in the subsonic and transonic part of a Laval nozzle, the method of computing the unsteady one-dimensional flow during explosions in the gas, the solution of the problem concerning the flow of a supersonic stream of conducting gas around blunt magnetized bodies and, finally, a calculation scheme of the numerical method of characteristics by layers, suitable for being applied to the case of calculating the flow around bodies under an angle of attack. Author (TAB)

N67-20340# Politecnico di Torino (Italy). Istituto di Meccanica Applicata.
FREE MOLECULE SURFACE SOURCES AND SINKS AND APPLICATIONS. PART II: COMPARISON WITH EXPERIMENTAL RESULTS Scientific Report No. 12
Silvio Nocilla Dec. 1965 23 p refs
(Grant AF-EOAR-63-98)
(TN-36; AFOSR-66-2741; AD-643879) CFSTI: HC $3.00/MF $0.65

A comparison is made between the theory developed in the first part (AD-631 101) and the experimental results obtained with the technique of the molecular beams by Datz, Moore and Taylor, Jawtusch, Smith and Fite, and some theoretical diagrams of magnitudes so far not measured experimentally are plotted. Author (TAB)

N67-20362# California Inst. of Tech., Pasadena. Div. of Engineering and Applied Science.
SOME HYDRODYNAMIC ASPECTS OF SUPERFLUID HELIUM
Din-Yu Hsieh Dec. 1966 55 p refs
(Contract N00014-67-0094-0009)
(Rept.-65-36; AD-644399) CFSTI: HC $3.00/MF $0.65

A brief critical survey on the hydrodynamic formulations of the superfluid helium is given first. For the irreversible process, three major formulations, i.e. those due to Gorter-Mellink, Lin, and Hall-Vinen, Bekarevitch-Khalatnikov, are described, discussed and compared. Then some results of analyses based on the Gorter-Mellink formulation are presented. The paper concludes with some interesting findings resulting from the assumption that rotons are vortex rings. Author (TAB)

13 GEOPHYSICS

Includes aeronomy; upper and lower atmosphere studies; oceanography; cartography; and geodesy. For related information see also: 20 Meteorology; 29 Space Radiation; and 30 Space Sciences.

N67-19389*# Geological Survey, Washington, D. C.
ASTROGEOLOGIC STUDIES. PART B: CRATER INVESTIGATIONS
Nov. 1966 274 p refs
(NASA Order R-66)
(NASA-CR-82745) CFSTI: HC $3.00/MF $0.65 CSCL 08G

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9. LARGE-SCALE PLANE WAVE SHOCK EXPERIMENTS DESIGNED FOR SAMPLE RECOVERY T. J. Ahrens, D. D. Keough (Stanford Res. Inst.), and D. J. Milton p 181–187 refs (See N67-19398 09-13)
10. INFLUENCE OF STRESS HISTORY ON LOW-TEMPERATURE THERMOLUMINESCENCE OF HALITE C. H. Roach p 189–230 refs (See N67-19399 09-13)
11. GEOLOGY OF THE MOSES ROCK INSTRUSTION, SAN JUAN COUNTRY, UTAH T. R. McGetchin p 231–253 refs (See N67-19400 09-13)

N67-19390*# Geological Survey, Washington, D. C.
HISTORY AND ORIGIN OF THE FLYNN CREEK CRATER, TENNESSEE Final Report
David J. Roddy *In its* Astrogeol. Studies, Pt. B Nov. 1966 p 1–39 refs (See N67-19389 09-13) CFSTI: HC $3.00/MF $0.65

A discussion of the origin of the Flynn Creek crater is presented in an effort to determine whether this structure originated from impact or volcanic gas phreatic explosions. Comparisons with four nuclear explosion craters indicate that structurally the Flynn Creek crater is nearly identical with the Jangle U nuclear crater. These structural comparisons served as the basis for the conclusion that the crater was also produced by a shock mechanism (impact). Petrographic studies of the zone of intense twinning also indicated a very high pressure environment during the formation of the crater. Data from trace-element studies did not indicate the presence of volcanic or meteoritic materials. The shallow depth of the crater, the presence of central uplift, and the anticlinal folding in the rim suggest that if an impact occurred, it was probably a shallow impact. Field studies have shown that the level of the original land surface supports the idea that confining pressures were very low. Simple scaling laws from nuclear explosion craters and the 500 ton TNT explosion crater suggest that between 10^{24} and 10^{25} was necessary to form the Flynn Creek crater. The suggestion that the evidence indicates an impact origin can be uniquely tested by a drilling program. Also included are data on the geologic history of the crater. S.C.W.

N67-19391*# Geological Survey, Washington, D. C.
GEOLOGY OF THE SIERRA MADERA STRUCTURE, TEXAS Progress Report
H. G. Wilshire *In its* Astrogeol. Studies, Pt. B Nov. 1966 p 41–70 refs (See N67-19389 09-13) CFSTI: HC $3.00/MF $0.65

Progress on the geologic study of the Sierra Madera cryptoexplosion structure in west Texas is described. The area of detailed mapping (Wilshire, 1965) was extended, and new data were obtained on lithology and stratigraphic relations of the Permian rocks exposed at Sierra Madera and in the nearby Glass Mountains. Structural data obtained from records of deep drill holes on and near Sierra Madera indicate that all parts of the structure are raised above the regional trend of the formations identified. Author

N67-19392*# Geological Survey, Washington, D. C.
SOME ASPECTS OF THE MANICOUAGAN LAKE STRUCTURE IN QUEBEC, CANADA
Stephen H. Wolfe *In its* Astrogeol. Studies, Pt. B Nov. 1966 p 71–78 refs (See N67-19389 09-13) CFSTI: HC $3.00/MF $0.65

Analyzed are results of a field study and petrographic analysis of samples from a ring of cliffs inside the shores of two arculate semicircular lakes, Manicouagan and Mushalagan, in the Grenville province of Canada. Three major rock units, distinct from the basement units, are described: (1) the deformed anorthosite from the central mountain; (2) the series of andesites and monzonites found in a ring around the central mountain and inside the two lakes; and (3) the inclusions of deformed basement rocks generally found in the andesites. Data from the literature are considered on the possible mode of formation of these rocks. Also included are analyses on the texture and distribution of the various rock types found in this area. It is surmised, on the basis of a study of a generalized section of monzonite–andesite units exposed at Manicouagan, that the monzonites and andesites do not show textures strongly indicative of shock metamorphism. On the basis of the data obtained it is also surmised that the cliff structure is the result of the impact of a large meteoritic mass. S.C.W.

N67-19393*# Geological Survey, Washington, D. C.
CRATERS PRODUCED BY MISSILE IMPACTS
H. J. Moore *In its* Astrogeol. Studies, Pt. B Nov. 1966 p 79–105 refs (See N67-19389 09-13) CFSTI: HC $3.00/MF $0.65

A study of impact craters produced by projectiles with energies between 2.10×10^{14} and 3.14×10^{15} ergs, is reported. The objectives of the study are to extend present knowledge of impact craters to those produced by projectiles with kinetic energies and to compare the dimensions and characteristics of the craters with those produced by chemical explosives. In addition, comparison is being made of the morphologies and ejecta of these craters with those of lunar craters seen in the Ranger 7, 8, and 9 photographs as well as those photographed by the Luna 9 and Surveyor 1. The data will also be used for other space projects such as Unmanned Orbiter and Apollo. Results indicate that: (1) The materials in and around impact craters in cohesive materials may be mapped and classified in the following six units with differing properties: target material, thick ejecta, thin to discontinuous ejecta, tilted and broken target material, shattered target material, and slope material; (2) Missile impact craters are the same size as craters produced by chemical explosives detonated at shallow depths when the kinetic energy of the missile is the same as the TNT energy equivalent of the explosive; and (3) Larger blocks may be ejected from larger craters if the rocks are well indurated and relatively unfractured. S.C.W.

N67-19394*# Geological Survey, Washington, D. C.
HYPERVELOCITY IMPACT CRATERS IN PUMICE
H. J. Moore and F. G. Robertson *In its* Astrogeol. Studies, Pt. B Nov. 1966 p 107–125 refs (See N67-19389 09-13) CFSTI: HC $3.00/MF $0.65

Preliminary results indicate that the sum of ejected and fragmented material from craters produced by the impact of hypervelocity projectiles with pumice at velocities between 3.95 and 7.66 km per sec is proportional to the momentum of the projectile (corrected for the ratio of projectile and target densities). This momentum dependence is also suggested in the size distributions of the sum of the ejecta and fragmented pumice from the crater, as well as in the amount of crushed and partly fused pumice in the debris. This momentum dependence may only represent a transition between low-velocity impacts and hypervelocity impacts. Results contrast with those for craters in solid materials such as basalt and metals for which sizes are essentially dependent on the kinetic energy of the projectile. The size distribution and petrography of the pumice debris imply that irreversible energy losses due to new surface and fusion may be the main factors in producing the momentum dependence of the sizes of craters in pumice. Author

N67-19395*# Geological Survey, Washington, D. C.
COMPILATION OF DATA ON CRATERS PRODUCED BY EXPLOSIVES
Francis G. Robertson *In its* Astrogeol. Studies, Pt. B Nov. 1966 p 127–134 refs (See N67-19389 09-13) CFSTI: HC $3.00/MF $0.65

Results of an analysis and subsequent compilation of data from the literature on craters produced by explosives are presented. Data on a total of 1,246 craters were collected and the information was further standardized for recording on punched cards so that machine processing could be used for sorting, plotting, and computational purposes. Examination of the data revealed that: (1) Craters in very wet materials may obey different scaling laws than those in dry materials over the whole energy range from 10^{14} to 10^{22} ergs; (2) The difference in crater sizes as a result of moisture content of the material is particularly distinct at energies near 10^{15} ergs; and (3) Sizes of craters produced by explosives with energies near 10^{13} ergs are strongly dependent upon cohesion and rock type of the material. S.C.W.

N67-19396*# Geological Survey, Washington, D. C.
IMPACT METAMORPHISM
E. C. T. Chao *In its* Astrogeol. Studies, Pt. B Nov. 1966 p 135–167 refs (See N67-19389 09-13) CFSTI: HC $3.00/MF $0.65

Reported are results of a study of meteorite impact metamorphism which was designed to establish diagnostic criteria for use in distinguishing craters of meteorite impact origin from circular structures of other origins. Evidence presented is based on studies of materials collected from Meteor Crater, Arizona; Ries crater, Saudi Aradia; and the Henbury craters, Northern Territory, Australia. Diagnostic petrographic criteria considered are: unique microstructures, selective phase transitions, formation of vitreous phases without evidence of viscous flow or vesiculation, the occurrences of high pressure polymorphs, and evidence of extremely high temperatures. Preliminary results of studies of progressive stages of meteorite impact metamorphism (sandstone, granite, and gneiss series) are included. Emphasized are the sequence of phase changes of a single mineral species, and textural and chemical changes of specific rock types resulting from different pressures and temperatures. Data on implications of the sequence of phase transitions and estimated pressures and temperatures during passage of a shock wave, and the importance of studies of impact metamorphic features in meteorites to studies of returned lunar samples, are also included. S.C.W.

N67-19397*# Geological Survey, Washington, D. C.
NICKEL–IRON SPHERULES FROM THE AOUELLOUL GLASS OF MAURITANIA, AFRICA
E. C. T. Chao, E. J. Dwornik, and Celine W. Merrill *In its* Astrogeol. Studies, Pt. B Nov. 1966 p 169–180 refs (See N67-19389 09-13) CFSTI: HC $3.00/MF $0.65

Petrographic, X-ray, and electron microscopic studies of the microstructure of nickel–iron sphericles found in several wafers of Aouelloul glass specimens were undertaken in an attempt to determine whether the Aouelloul crater is a genuine meteorite crater, how the Aouelloul glass was formed, and whether it was derived from the underlying bedrock of the Aouelloul crater. Electron microprobe analyses showed that the spherules consisted mostly of iron, with a nickel content ranging from 1.7 to 9.0%, and it was concluded that the occurrence of nickel–iron in the Aouelloul glass was proof that the Aouelloul crater is a genuine meteorite crater. Electron microprobe analyses of the iron content along a traverse across the gray glass, clear glass, and the brown matrix glass were made to determine whether Aouelloul glass is a tektite of possible lunar origin. On the basis of evidence presented it was concluded that the glass is an impactite of terrestrial origin and not a tektite. S.C.W.

N67-19398*# Geological Survey, Washington, D. C.
LARGE-SCALE PLANE WAVE SHOCK EXPERIMENTS DESIGNED FOR SAMPLE RECOVERY
T. J. Ahrens, D. D. Keough (Stanford Res. Inst., Menlo Park, Calif.), and D. J. Milton *In its* Astrogeol. Studies, Pt. B Nov. 1966 p 181–187 refs (See N67-19389 09-13) CFSTI: HC $3.00/MF $0.65

Described is an experimental assembly for explosive shock loading of rock specimen in the laboratory. The assembly is an adaptation of the mousetrap plane wave generator and produces a planar shock wave and an associated relatively planar particle velocity flow field over an area of nearly half a square meter. Such an assembly is expected to deliver a peak shock pressure on the order of 250 kilobars for approximately 10 microseconds with a reasonable weight of explosive. The explosive configuration should allow the pressure profile induced in a given rock type to be measured in the laboratory using, for example, a tombstone-sized sample of rock, and to be calculated using a one dimensional time dependent computer code. Results of tests of two prototype explosive assemblies are reported. Speculation is made concerning the possible usefulness of the proposed assembly in the elimination of uncertainties introduced into the calculation of the pressure and temperature history of multiply shocked laboratory specimen. S.C.W.

N67-19399*# Geological Survey, Washington, D. C.
INFLUENCE OF STRESS HISTORY ON LOW-TEMPERATURE THERMOLUMINESCENCE OF HALITE
Carl H. Roach *In its* Astrogeol. Studies, Pt. B Nov. 1966 p 189–230 refs Sponsored by ARPA (See N67-19389 09-13) CFSTI: HC $3.00/MF $0.65

The effects of two underground nuclear explosions on the thermoluminescence of surrounding halite (rock salt) was studied to determine the influence of unusual shock or stress histories on thermoluminescence characteristics of common rock forming minerals. Experimental studies were conducted to determine, under known conditions, if the low temperature thermoluminescence characteristics of halite could be significantly altered by a shock or stress event. A cylindrical core of halite from the site of the Salmon underground nuclear explosion was used for a shock loading experiment. Results indicate that both shock waves and relatively slow rates of applied stress accompanying triaxial compression tests significantly alter the low temperature thermoluminescence of halite. Shock induced low temperature thermoluminescence of rock salt at the Gnome site was also studied to determine if strong shock waves associated with the detonation of an underground nuclear explosion would significantly alter the low temperature thermoluminescence of enclosing halite. Results indicate that shock derived from the Gnome nuclear explosion induced significant amounts of low temperature thermoluminescence in the halite adjacent to the point of origin of shock. Studies at the Gnome and Dribble sites and numerous laboratory shock and stress experiments showed that the amount of stress induced low temperature thermoluminescence at any particular point in a body of plastically deformed halite is very sensitively affected by the presence of physical irregularities. Data further indicated that thermoluminescence techniques have great potential application to the broad field of rock mechanics as well as to many related geological problems. S.C.W.

N67-19400*# Geological Survey, Washington, D. C.
GEOLOGY OF THE MOSES ROCK INTRUSION, SAN JUAN COUNTY, UTAH
Thomas R. McGetchin *In its* Astrogeol. Studies, Pt. B Nov. 1966 p 231–253 refs (See N67-19389 09-13) CFSTI: HC $3.00/MF $0.65

Described are the dike structure, intrusive material, equilibrium block size, duration of eruption and flow history, size–depth relationship for upward displaced blocks, thickness of overburden, and inferred history of emplacement of the Moses Rock intrusion. S.C.W.

N67-19412# Toronto Univ. (Ontario).
UPPER ATMOSPHERIC RESEARCH
In its Ann. Progr. Rept., 1966 Oct. 1966 p 73–74 (See N67-19403 09-34)

Upper atmospheric research was conducted to report and analyze rocket measurements at high altitudes. The payload of a second rocket flight will carry, in addition to the former equipment, a new package for the measurement of temperature by the electron beam-fluorescence technique. Two approaches to the pumping system for the gun chamber were investigated: a zeolite cryosorption pump and a titanium sublimator joined to a cryosorption pump. S.P.

N67-19501*# Geological Survey, Washington, D. C.
ASTROGEOLOGIC STUDIES. PART C: COSMIC CHEMISTRY AND PETROLOGY

Oct. 1966 130 p refs
(NASA Order R-66)
(NASA-CR-82837) CFSTI: HC $3.00/MF $0.65 CSCL 08D

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3. THE OCCURRENCE AND ORIGIN OF LAMELLAR TROILITE IN IRON METEORITES E. P. Henderson (Natl. Museum) and R. Brett p 35–53 refs (See N67-19504 09-13)

4. ELECTRON MICROSCOPY OF MICROMETEORITES COLLECTED ON THE 1965 LUSTER EXPERIMENT M. H. Carr and H. J. Gabe p 55–65 refs (See N67-19505 09-30)

5. NEW TECHNIQUES IN GEOCHEMICAL ANALYSIS I. May and F. Cuttitta p 67–112 refs (See N67-19506 09-13)

6. THE SIMULTANEOUS DETERMINATION OF Cs, Hf, AND Ta BY NEUTRON ACTIVATION P. Greenland p 113–114 (See N67-19507 09-06)

7. SPECTROGRAPHIC DETERMINATION OF ZINC AND SILVER IN SILICATES USING AN ARGON-D-C ARC C. Annell p 115–121 refs (See N67-19509 09-13)

N67-19502*# Geological Survey, Washington, D. C.
METALLIC SPHERULES IN IMPACTITE AND TEKTITE GLASSES
Robin Brett *In its* Astrogeol. Studies, Pt. C Oct. 1966 p 1–19 refs (See N67-19501 09-13) CFSTI: HC $3.00/MF $0.65

Nitrogen enrichment in spherules of impactite bombs, composed mainly of glass that formed from rock and soil when a meteorite hit the earth, is attributed to oxidation of the Ni–Fe spherules. The Ni enrichment in the ablation rim of the Bogou meteorite is attributed to oxidation, as are the high Ni contents of some spherules considered to be of cosmic origin. The high Ni content of the spherules in impactite glass as compared with that of the tektite is attributed to the loss of the iron component via oxidation; and the lost iron is found in the glass itself. Since the Ni enrichment cannot be explained by fractionation due to partial vaporization or melting of meteoritic metal, four models that explain the oxidation of metallic spherules in impactites are considered. M.W.R.

N67-19503*# Geological Survey, Washington, D. C.
MARTHA'S VINEYARD AND SELECTED GEORGIA TEKTITES: NEW CHEMICAL DATA
Frank Cuttitta, R. S. Clarke (Natl. Museum, Washington, D. C.), M. K. Carron, and Charles S. Annell *In its* Astrogeol. Studies, Pt. C Oct. 1966 p 21–33 refs Prepared jointly with Natl. Museum (See N67-19501 09-13) CFSTI: HC $3.00/MF $0.65

Chemical composition and ages indicate that the Georgia and Martha's Vineyard tektites represent the high silica end members of the North American tektite family; and a common origin by both event and parent body is suggested for these two tektites and the Texas one. Formation of these natural glasses may be the result of fusion of an unknown target area in a meteoritic impact. The North American tektite family exhibits a continuous range of variation in SiO_2, Al_2O_3, FeO, and TiO_2; are low in MgO, CaO, and K_2O; and are very low in water content. Compositional data for the tektites reflect the effects of differential volatilization, and virtually all their iron is in the ferrous state and displays a characteristic low ferrite-ferrous iron ratio averaging 0.040. M.W.R.

N67-19504*# Geological Survey, Washington, D. C.
THE OCCURRENCE AND ORIGIN OF LAMELLAR TROILITE IN IRON METEORITES
Robin Brett and E. P. Henderson (Natl. Museum, Washington, D. C.) *In its* Astrogeol. Studies, Pt. C Oct. 1966 p 35–53 refs (See N67-19501 09-13) CFSTI: HC $3.00/MF $0.65

Formation of troilite bodies in meteorites is attributed to a sulfide melt, with an extremely minor contribution coming from troilite exolved in the solid state. Two main troilite bodies, referred to as lamellae, were examined. Type 1 lamellae oxidize very readily to magnetite and limonite; and unoxidized lamellae are difficult to find. These lamellae in iron meteorites appear to have formed by filling of fractures; and the well-oriented bodies may be the result of recrystallization of the residual sulfide liquid in oriented interstices in the nickel-iron. The type 2 lamellae appear to have formed in more rapidly cooled iron meteorites. Their origin may be from a relatively small parent body or the result of cooling crossed-beam the surface of a large body. Nucleation at the troilite-metal interface during the formation of the Widmanstätten texture causes the formation of swathing kamacite surrounding troilite in iron meteorites. M.W.R.

N67-19506*# Geological Survey, Washington, D. C.
NEW TECHNIQUES IN GEOCHEMICAL ANALYSIS
Irving May and Frank Cuttitta *In its* Astrogeol. Studies, Pt. C Oct. 1966 p 67–112 refs (See N67-19501 09-13) CFSTI: HC $3.00/MF $0.65

Modern trends in geochemical analysis, including methods for the analysis of small samples and trace contaminants in large samples are reviewed. Chromatographic methods discussed are those using gas, thin layers, columns, or paper; and applications of the first two methods are considered. Separation techniques, radioactivity measurements, and automation are discussed for activation analysis. Fission track analysis and Mossbauer spectrometry are also considered; and atomic absorption spectrometry is discussed in relation to flames and burners, sources, instrumentation, sensitivity enhancement and elimination of interference, atomic fluorescence, and geochemical applications. Recent developments are discussed for excitation by controlled atmosphere arc, inert atmosphere spark, laser microprobe, microspark, and plasma jet. Aspects of X-ray fluorescence spectroscopy treated are crystal analysis; detectors, tubes, and instrumental developments; related chemical techniques; and geochemical applications. M.W.R.

N67-19579# Massachusetts Inst. of Tech., Cambridge. Dept. of Civil Engineering.
THE RESPONSE OF SOILS TO DYNAMIC LOADINGS. REPORT 25: MISCELLANEOUS STUDIES OF THE FORMATION OF WAVE FRONTS IN SAND
Robert V. Whitman May 1966 64 p refs *Its* Soils Publ.-196
(Contract DA-22-079-eng-224)
(R66-32; Rept.-3-26; AD-640753) CFSTI: HC $3.00/MF $0.65

This report contains: (1) Data concerning the stress-strain behavior of dry Monterey sand using initial static stresses ranging from 2 to 20 psi: (a) Stress-strain curves for one-dimensional compression with rise-times on the order of 25 milliseconds and stress increments of 100 psi; (b) Dilatational wave velocities measured using ultrasonic pulses and pulses generated by a hammer blow; (2) Theory for the dispersion of a wave front passing through a system of discrete particles. Author (TAB)

N67-19613# Lockheed Missiles and Space Co., Palo Alto, Calif. Research Lab.
THE VALIDITY OF THE O_2^- MODEL FOR D-REGION RECOMBINATION
Alfred Kaufman Nov. 1966 18 p refs
(Contract Nonr-3368(00))
(LMSC-2-12-66-6; AD-644354) CFSTI: HC $3.00/MF $0.65

The adequacy of the O2(-) model for predicting the response of the atmosphere to ionizing radiation is examined in the light of observations of (1) nuclear weapon effects and (2) polar cap

absorption events. The model appears to give reasonable agreement with observations in the first category, but is inconsistent with data from the second. The inadequacy of the model seems to be related to the amount of atomic oxygen and ozone naturally present and produced during recombination. Latest measurements of rate constants for several important negative ion reactions are also given. Author (TAB)

N67-19615# Army Electronics Labs., Fort Monmouth, N. J.
VARIABILITY OF WISCONSIN AREA ATMOSPHERIC LIGHT TRANSMISSION
Andrew Petriw and Israel Cantor Jun. 1966 29 p refs
(ECOM-2728; AD-640574) CFSTI: HC $3.00/MF $0.65

The direct component portion of a large quantity of atmospheric light-transmission data being analyzed exhibits rather large fluctuations which have generated variations in corresponding computed attenuation coefficients. This report describes the results of comparisons between two different sample sizes of the data, made in an effort to reduce the degree of variation. The report also shows the magnitude of variation that occurred during similar transmission conditions. Author (TAB)

N67-19648# Auroral Observatory, Tromso (Norway).
AlO RESONANT SPECTRUM FOR UPPER ATMOSPHERE TEMPERATURE DETERMINATION
Ove Harang May 1966 34 p refs Prepared in cooperation with Northwestern Univ. *Its* Environ. Res. Paper No. 192
(Contracts AF 19(628)-5731; AF 61(052)-906)
(AFCRL-66-314; AD-641359) CFSTI: HC $3.00/MF $0.65

The release of diatomic species, in particular AlO, into the upper atmosphere at twilight results in luminous clouds that display the resonance electronic-vibrational rotational spectrum of the released species. The intensity distribution of the vibrational-rotational bands is temperature dependent. Assuming thermal equilibrium of the released species with ambient, the ambient temperature can be determined. Using the AlO molecular parameters, Franck-Condon factors, and the solar intensity in the upper atmosphere, the population of AlO in the vibrational and rotational levels and the relative band intensities are calculated, tabulated, and charted. These charts will be useful for upper atmosphere temperature measurements from AlO luminous clouds. Author (TAB)

N67-19731# White Sands Missile Range, N. Mex. Atmospheric Sciences Lab.
BASIC CONSIDERATIONS IN THE DEVELOPMENT OF AN UNGUIDED ROCKET TRAJECTORY SIMULATION MODEL
Louis O. Duncan Sep. 1966 33 p refs
(ECOM-5076; AD-642855) CFSTI: HC $3.00/MF $0.65

The basic requirements for the development of a six-degree-of-freedom digital simulation model are outlined, and three coordinate systems are specified which are both adequate and convenient for such a development. The nontrivial coordinate transformations are shown. The equations of motion are developed, with indications of the standard assumptions. The principal forces and moments are discussed. The thrust misalignment effects are derived and the formulas for the jet damping moment are included. Aerodynamic forces and moments are discussed, and the necessary aerodynamic angles are defined. These forces and moments are described from the stability derivative point of view, and components of the major forces and moments are derived. Author (TAB)

N67-19780# Army Electronics Labs., Fort Monmouth, N. J.
PHOTOELASTIC MODELING TECHNIQUES FOR SEISMIC WAVE PROPAGATION
Ronald F. Johnson Oct. 1966 37 p refs
(ECOM-2769; AD-644590) CFSTI: HC $3.00/MF $0.65

The mechanical and optical properties of gelatins are employed for modeling of acoustical wave propagation phenomena in various media. The functioning of experimental active seismic systems for communications, surveillance, and prospecting is demonstrated by visual stroboscopic display of elastic and plastic waves in gelatin models for various types of soil. Applications of these modeling techniques to design, construction, and deployment of acoustical transmitters and receivers are given. Author (TAB)

N67-19808# Boston Coll., Chestnut Hill, Mass.
THE NEW ENGLAND SEISMIC NETWORK. Final Report, 16 Feb. 1962–15 Sep. 1966
F. Thomas Turcotte Bedford, Mass., AFCRL, 15 Oct. 1966 37 p refs
(Contract AF 19(628)-358; ARPA Order 292; Proj. Vela-Uniform)
(AFCRL-66-757; AD-644200) CFSTI: HC $3.00/MF $0.65

A short period seismographic network consisting of five stations in the New England region has been established and maintained. Seismic data from the four northern stations are telemetered to the fifth station at Weston. Refraction studies have determined the crustal thicknesses underlying the four northern stations. The correlation of these results south to Weston is questionable. Anomalous departures of arrival times from the Jeffreys-Bullen Travel-time Tables have been observed as a function of azimuth of approach to the stations. The regional seismicity of New England and adjacent areas is summarized from November 1962 through September 1966. Preliminary work with crustal transfer functions applicable to the New England region is described, and a ray theory explanation given for the impulse response obtained from such transfer functions. Author (TAB)

N67-19816# Aeronautical Chart and Information Center, St. Louis, Mo. Linguistic Section.
EXPERIMENT IN DETAILED GRAVIMETRIC SURVEYING AT SEA
Yu. N. Avsyuk and V. A. Kuzivanov Nov. 1966 6 p Transl. into ENGLISH of the book "Apparatura i Metody Morskikh Gravimetricheskikh Nablyudeniy" Moscow, Publishing House "Nauka", 1965 p 118–120
(ACIC-TC-1117; TT-67-60082; AD-642793) CFSTI: HC $3.00/MF $0.65

A detailed gravimetric survey over a 20 x 30 mile square at sea was conducted. The purpose of the expedition was to process a method for observations and obtain data for a detailed survey in regions with varying anomalousness: with great (of the order of 20 mgl/mile) and small (1 mgl/mile) gradients of the gravitational force. The routes in the square were organized in such a way that five of them were passing at a distance of 7 miles from each other along the meridians, three at 10 mile intervals along the parallels and two routes crossed the square diagonally. Such a planning of routes made it possible to carry out a uniform survey together with control measurements. In all routes the observations were conducted during the forward and reversed motions. The coordinates of the ships position were determined by the means of radio facilities at the beginning and end of each route. During the travel along the route the coordinates were determined by computations. TAB

N67-19835# Cambridge Acoustical Associates, Inc., Mass.
ANALYTICAL STUDY OF CERTAIN ASPECTS OF UNDERWATER SHOCKWAVE PROPAGATION: SLOPING BOTTOM, ICECAP, SEDIMENTARY BOTTOM. Final Report
David Feit and William Thompson, Jr. Oct. 1966 49 p refs
(Contract Nonr-3939(00))
(U-246-174; AD-644197) CFSTI: HC $3.00/MF $0.65

Various problems concerning the effects of the boundaries of the ocean on the propagation of pressure waves in the ocean are considered. The propagation of a transient pressure wave in a wedge shaped region of fluid is treated. This is the model chosen to describe the situation in which an underwater explosion takes place in a coastal region which is characterized by a strongly sloping bottom. In an attempt to study the effects of the polar ice cap on the propagation of a pressure wave, the reflection of a

plane wave onto a rough boundary separating a fluid half space and a thick fluid layer of differing sound speed and density is considered. These results are currently being used to construct the response to a transient pressure pulse and to generate numerical results for conditions representative of underwater explosions. The final section presents numerical values of the reflection coefficient as a function of grazing angle for the case of a plane wave incident on a porous elastic bottom. Author (TAB)

N67-19867*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THE POLAR CAP ABSORPTION ON JULY 7–10, 1966
Yukio Hakura Mar. 1967 22 p refs
(NASA-TM-X-55720; X-641-67-116) CFSTI: HC $3.00/MF $0.65 CSCL 04A

Time history of a PCA on July 7–10, 1966 was analyzed using 16 riometers in the northern polar region and concurrent satellite observations of solar cosmic radiations. The PCA was attributed to a solar flare of importance 3 observed at 00:25 U.T. on July 7, that was accompanied by a major radio outburst of type IV. The first onset of PCA was noticed at 01:20 U.T. at Shepherd Bay, and the slight enhanced ionization of a few tenths of db covered the whole north pole region before 02:00 U.T. On the other hand, auroral zone stations observed the PCA after 02:00. The two-stepped onset of the PCA corresponds to the differential arrival of solar electrons and protons at the earth, detected by the satellite IMP-3. The PCA in the polar region marked a maximum of 2.5 db on 30 Mc/s at 13:00 on July 7, and then decayed gradually until it went down below 0.3 db after 23:45 on July 8. There was no discontinuous decrease in absorption in polar riometer as observed in the interplanetary proton intensity in association with an inter-planetary shock wave, while the auroral zone stations observed a pronounced Sudden Commencement Absorption. Author

N67-19868* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
GEOMAGNETIC EULER POTENTIALS
David P. Stern Feb. 1967 25 p refs
(NASA-TM-X-55719; X-641-67-106) CFSTI: $3.00 CSCL 08N

A perturbation scheme is developed here by which, given the spherical harmonic expansion of the geomagnetic scalar potential and treating it as representing a perturbed dipole field, Euler potentials can be derived to any desired order of accuracy. Its first-order solutions involve trigonometric integrals $V_n^m(\theta)$ and $W_n^m(\theta)$ previously defined by Pennington, which may be expressed in closed form; tables of coefficients enabling one to obtain these integrals up to n=6 are included. The results are tested for the internally generated geomagnetic field by mapping lines of constant α and β on the earth's surface; conjugate points (which have the same α and β) are obtained with typical accuracy of 1–2 degrees. The method is also applied to a magnetospheric model in which external sources are added to represent the effect of the solar wind; although this model clearly breaks down at large distances, it gives fairly good results within about 10 earth radii, including a "magnetopause" on which two neutral points are located. Author

N67-19929*# Geophysics Corp. of America, Bedford, Mass. Technology Div.
EXPERIMENTAL AND THEORETICAL STUDIES IN PLANETARY AERONOMY
F. F. Marmo Sep. 1966 84 p refs
(Contract NASw-1283)
(NASA-CR-82937; GCA-TR-66-19-N) CFSTI: HC $3.00/MF $0.65 CSCL 04A

Summaries, bibliographies, and abstracts of individual publications on the physics of planetary atmospheres are presented along with technical summaries of unpublished results. The broad variety of scientific areas which have been considered are discussed under the following major categories: (1) photochemistry of planetary atmospheres, (2) theoretical studies, (3) laboratory investigations in the vacuum and extreme ultraviolet spectral regions, and (4) planetary aeronomy. A.G.O.

N67-19977# Institut d'Aeronomie Spatiale de Belgique, Brussels.
CHARGED PARTICLE TEMPERATURES AND ELECTRON THERMAL CONDUCTIVITY IN THE UPPER ATMOSPHERE
Peter M. Banks 1966 33 p refs Submitted for publication
(A-48-1966)

The thermal conductivity of the electron gas plays an important part in determing the profiles of electron and ion temperature in the upper atmosphere. Previous calculations have been based upon the thermal conductivity derived for a fully ionized gas. In aeronomic conditions, however, the contribution made by neutral gas particles must be introduced. In this paper an analysis is made of the effect of electron-neutral particle collisions and an appropriate expression is developed for the electron thermal conductivity which is applicable to a weakly ionized plasma. It is found that a correction term needed to include the effect of neutral particles is of importance during both day and night at all altitudes below 220 km. In fact, at altitudes below 135 km it appears that the conduction term can be neglected in the electron energy balance equation. Using the derived expression for the effective electron thermal conductivity, an example of calculated temperatures characteristic of quiet solar conditions is presented. ESRO

N67-20168* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
U.S. COAST AND GEODETIC SURVEY–NASA GEOMAGNETIC DATA REDUCTION PROGRAM
Joseph C. Cain, Folke Eleman, S. J. Hendricks, Herbert Meyers, William Paulishak (Coast and Geoderic Survey, Washington, D. C.) et al al Jan. 1966 31 p refs
(Grant NSF GP-2277)
(NASA-TM-X-55661; X-612-66-11) CFSTI: $3.00 CSCL 08N

The need for a comprehensive collection of digital data in computer format for direct analysis is stressed, with particular emphasis placed on the urgent problem of processing data that can be correlated with other experiments. Data categories which have been established are listed; these include mean hourly scaling, normal magnetograms, observatory annual means, and world magnetic survey data. The procedures for digitizing magnetograms are discussed, and the observatories from which they were obtained are listed. Suggestions are also included on the steps to be followed in preparing and editing magnetograms which are to be microfilmed for submission to the World Data Centers. M.G.J.

N67-20175# Aerospace Research Labs., Wright-Patterson AFB, Ohio.
CORRELATION OF SOME LABORATORY EXPERIMENTS IN TWO-PHASE FLOW WITH PHENOMENA AT THE AIR–SEA INTERFACE
Alfred C. Pinchak Aug. 1966 46 p refs
(ARL-66-0159; AD-643767) CFSTI: HC $3.00/MF $0.65

Results of laboratory experiments dealing with wave formation and droplet entrainment in two-phase flow systems are presented here. Data concerning the effective interfacial shear stress between the gas and liquid are given and compared with similar air-sea data. By means of an extrapolation technique, the critical velocity for droplet entrainment in laboratory experiments is related to the corresponding critical velocity in the air-sea case. Analysis of a simplified model of the entrainment process indicates a reduction in the effective interfacial shear stress with increasing entrainment. However, the stress reduction is less than in direct proportion to the amount of entrainment. Author (TAB)

N67-20265*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
ATMOSPHERIC APPLICATION OF THE CROSS-BEAM TECHNIQUE

William O. Davies and Robert W. Deuel (IIT Res. Inst., Chicago, Ill.) *In its* Aero-Astrodyn. Res. Rev. No. 5 15 Oct. 1966 p 38–46 refs (See N67-20261 09-34)
(Contracts NAS8-11258; NAS8-20107)

The investigation of atmospheric phenomena using a cross-beam technique is considered for two particular cases, quiet nightglow radiation fluctuations and emission or absorption changes due to atmospheric ozone. For each case, experiments would begin with a single-beam observation to determine integrated path signal characteristics. Subsequent correlated paths. Calculations indicate an expected high-frequency contribution to the fluctuation spectrum due to the generation-decay processes of the species involved in the observed radiative transition. Variations caused by the transport of cells representative of wind and turbulence characteristics across and within the field of view are expected to produce lower frequency spectral features. Details of source strength, extinction effects, and correlated volume resolution must be considered for each case. Author

N67-20286*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
FEASIBILITY AND POTENTIAL OF ATMOSPHERIC CROSSED-BEAM EXPERIMENTS
F. R. Krause, J. C. La France, S. V. Paranjape (Northrop Space Labs., Huntsville, Ala.), and J. B. Stephens *In its* Aero-Astrodyn. Res. Rev. No. 5 15 Oct. 1966 p 47–67 refs (See N67-20261 09-34)
(Contract NAS8-20082)

The feasibility and potential of crossed-beam experiments in the lower atmosphere are illustrated by considering the operation which would be necessary to measure a horizontal wind profile up to altitudes of 30 km. It is shown that natural sources of radiation such as scattered solar radiation, ozone emission, and infrared radiation of the sky and earth's surface existed at sufficient levels to be useful in the corssed-beam technique. The determination of convection speeds, length scales, wave number components, and the power spectrum using crossed-beam scanning is also demonstrated. A.G.O.

N67-20284# New Zealand. Dept. of Scientific and Industrial Research, Wellington.
HIGH LATITUDE NIGHT SKY EMISSIONS
B. P. Sandford Aug. 1966 16 p refs Presented at the Advanced Study Inst. on Aurora and Airglow, Keele, England, Aug. 1966 Submitted for publication
(R-329) CFSTI: HC $3.00/MF $0.65

A review of the morphology and general features of some optical emissions generated in the upper atmosphere at high latitudes is given. It is revealed that the aurorae should be considered as a complex family of phenomena of which the classical, discrete visible aurora represents only one aspect. Other types of emission discussed are the mantle aurora, proton excited aurora, polar-glow aurora, red line emission and airglow. These other types of emission are generally not visible to the naked eye but their integrated light flux exceeds that generated by the discrete visible aurora. Author (ESRO)

N67-20299# Max-Planck-Institut fur Physik und Astrophysik, Munich (West Germany).
ARTIFICIAL STRONTIUM AND BARIUM CLOUDS IN THE UPPER ATMOSPHERE
H. Foeppl, G. Haerendel, L. Haser, J. Loidl, P. Luetjens et al Aug. 1966 35 p refs
(MPI-PAE/EXTRATERR.-34/66) CFSTI: HC $3.00/MF $0.65

Experiments with strontium and barium vapor releases in the upper atmosphere, carried out in the Sahara and in Sardinia in 1964, are discussed. The yield of evaporated metal was tested for different chemical reactions. Sr proved to have efficiencies up to 40%. For Ba a mixture of CuO Ba gave the best results with a yield of nearly 7%. No Sr ions were observed in the experiments. Ba however is strongly ionized. The diameter of the neutral clouds increased as one would expect for purely molecular diffusion. The rate of increase in the central intensity of the clouds at sunrise was greater than the rate of decrease at sunset. Atmospheric wind velocities of 50–130 $msec^{-1}$ were determined from the motion of the neutral clouds. The motion of the ion clouds perpendicular to the earth's magnetic field indicated the presence of electric fields. The initial expansion velocity for explosive mixtures was greater by about a factor of 4 than the mean thermal velocity of the atoms at a temperature of about 3000°K. Author (ESRO)

N67-20304# Weapons Research Establishment, Salisbury (Australia).
IONOSPHERIC DATA FOR FEBRUARY 1966 FROM WOOMERA, SOUTH AUSTRALIA
Aug. 1966 24 p
(WRE-CPD-1966/2(W)) CFSTI: HC $3.00/MF $0.65

Tables of the hourly values of the customary ionospheric parameters are given for the station at Woomera for February 1966. Author

N67-20324# Ionosphären-Institut Breisach (West Germany).
IONOSPHERE DATA, VERTICAL-ECHO-SOUNDING: FREIBRRG, URSI-CODE 131, APRIL–JUNE [IONOSPHAE-REN-DATEN, VERTIKAL-ECHO-LOTUNGI FREIBURG USRI-CODE 131, APRIL–JUNI 1966]
[1966] 119 p In GERMAN and ENGLISH
(Rept.-238-F; Rept.-239-F; Rept.-240-F) CFSTI: HC $3.00/MF $0.65

Presented are the ionospheric measurements obtained at Freiburg, Germany, during the months April through June, 1966, by vertical echo soundings. Tables and punch card codes contain wave frequencies for the F2-, F1-, and the E-layer as well as the critical frequency for a transient stratification in the F-region. Transl. by G.G.

N67-20330# Royal Aircraft Establishment, Farnborough (England).
ODD ZONAL HARMONICS IN THE GEOPOTENTIAL, DETERMINED FROM 14 WELL-DISTRIBUTED SATELLITE ORBITS
D. G. King-Hele, G. E. Cook, and Diana W. Scott Sep. 1966 49 p refs
(RAE-TR-66317) CFSTI: HC $3.00/MF $0.65

Coefficients of the odd zonal harmonics in the Earth's graviational potential are evaluated by analysing the oscillations in orbital eccentricity of 17 satellites, chosen to give the widest and most uniform possible distribution in inclination and semi major axis. Three of the satellities are excluded for various reasons; the other 14 yield various sets of values for the odd zonal harmonic coefficients. The best representations of the odd harmonics in the potential appear to be in terms of either 7 or 10 coefficients, assuming that higher-degree coefficients are zero. The two sets of values are tabulated. Author

N67-20367# Weapons Research Establishment, Salisbury (Australia).
IONOSPHERIC DATA FOR AUGUST 1966 FROM SALISBURY, SOUTH AUSTRALIA
Sep. 1966 24 p ref
(WRE-CPD-1966/8(S)) CFSTI: HC $3.00/MF $0.65

Tables of the hourly values of the customary ionospheric parameters are given for the station at Salisbury (34.7°S and 138.6°E) for August 1966. The various characteristics of the operating radiosonde are also listed. Author

N67-20369# Weapons Research Establishment, Salisbury (Australia).
IONOSPHERIC DATA FOR MARCH 1966 FROM WOOMERA, SOUTH AUSTRALIA
Sep. 1966 24 p ref
(WRE-CPD-1966/3(W)) CFSTI: HC $3.00/MF $0.65

Tables of the hourly values of the customary ionospheric parameters are given. The ionosonde characteristics are included.
Author

N67-20370# Weapons Research Establishment, Salisbury (Australia).
IONOSPHERIC DATA FOR JULY 1966 FROM SALISBURY, SOUTH AUSTRALIA
Aug. 1966 24 p ref
(WRE-CPD-1966/7(S)) CFSTI: HC $3.00/MF $0.65

Tables of the hourly values of the customary ionospheric parameters are given.
Author

14 INSTRUMENTATION AND PHOTOGRAPHY

Includes design, installation, and testing of instrumentation systems; gyroscopes; measuring instruments and gages; recorders; transducers; aerial photography; and telescopes and cameras.

N67-19423# Oak Ridge National Lab., Tenn.
INSTRUMENTATION AND CONTROL DIVISION ANNUAL PROGRESS REPORT, FOR PERIOD ENDING SEPTEMBER 1, 1966
Aug. 1966 239 p refs
(Contract W-7405-ENG-26)
(ORNL-3875) CFSTI: HC $3.00/MF $0.65

Nanosecond circuitry and techniques, pulse counting and analysis, electrometers and accessories, miscellaneous electronics development, fabrication and maintenance of electronic instruments, instrumentation for automatic control, instrumentation for biomedical research, detectors of ionizing particles and radiation, radiation monitoring, data collection and analysis, process instrumentation and control systems engineering and process instrumentation development are presented. For individual titles see N67-19424–N67-19450.

N67-19427# Oak Ridge National Lab., Tenn.
MISCELLANEOUS ELECTRONICS DEVELOPMENT
In its Instrumentation and Control Div. Ann. Progr. Rept., for Period Ending Sep. 1, 1965 Aug. 1966 p 15–20 ref (See N67-19423 09-14) CFSTI: HC $3.00/MF $0.65

Electronic instrumentation was developed to measure the magnetic moment of superconducting materials by detecting the Meissner effect. Also reported in the miscellaneous electronics development program are: tests on a 20-pin Amperex photomultiplier tube socket; transfer-function simulation of a pulse amplifier for aerosol particle-size analysis; remotely operated range wheel, high-voltage power supply for electron beam heating; and noise-signal pickup in instrumentation circuits.
R.Li.

N67-19428# Oak Ridge National Lab., Tenn.
FABRICATION AND MAINTENANCE OF ELECTRONIC INSTRUMENTS
In its Instrumentation and Control Div. Ann. Progr. Rept., for Period Ending Sep. 1, 1965 Aug. 1966 p 21–23 refs (See N67-19423 09-14) CFSTI: HC $3.00/MF $0.65

Concise technical details are reported on product design, fabrication, maintenance, and quality control of the following electronic instruments: differential or integral discriminator, linear amplifier, bin power supply, gamma process monitor, dE/dX system, and alpha process monitor. An electronic section organization chart, showing field service and maintenance effort of electronic instruments and systems, is also presented.
R.Li.

N67-19429# Oak Ridge National Lab., Tenn.
INSTRUMENTATION FOR AUTOMATIC CONTROL
In its Instrumentation and Control Div. Ann. Progr. Rept., for Period Ending Sep. 1, 1965 Aug. 1966 p 24–34 refs (See N67-19423 09-14) CFSTI: HC $3.00/MF $0.65

Technological advancements for several automatic control instruments are reported. Concepts covered include: adjustable ramp generator for power controller, thermal conductivity response of catalytic combustion detectors in gas chromatography, control systems for automatic welding, electronic etch controller for electron microscope specimens, computer-controlled x-ray diffractometer, automatic sample changer, and automatic control system for a microfiche printer. Graphics are presented on furnace power controller, catalytic detector system, automated welding system, welding program recording system connection diagram, arc suppressor, and recorder protector.
R.Li.

N67-19430# Oak Ridge National Lab., Tenn.
INSTRUMENTATION FOR BIOMEDICAL RESEARCH
In its Instrumentation and Control Div. Ann. Progr. Rept., for Period Ending Sep. 1, 1965 Aug. 1966 p 35–43 refs (See N67-19423 09-14) CFSTI: HC $3.00/MF $0.65

For biomedical research application, instrumentation for measuring light emissions from green plants is briefly described. Photosynthesis reaction was studied with the aid of an electro-optical shutter (Kerr cell) by measuring the delayed light emission an order of magnitude faster than the previously reported 50μ sec after cessation of illumination. A fluorescent dye, rhodamine, whose decay is known to be faster than the shutter operation, was used to check the response in *Chlorella* algae of the electronic system. The effect of the decay resulting from inhibiting photosynthesis by the addition of 10^{-4} M hydroxylamine is depicted. Two simple devices were developed which, when connected to a digital voltmeter-counter and printer, provide easier, faster, and more accurate measurements of measuring human chromosome length for identification purposes. Also mentioned is the application of a digital memory oscilloscope to delayed-light measurements.
R.Li.

N67-19431# Oak Ridge National Lab., Tenn.
DETECTORS OF IONIZING PARTICLES AND RADIATION
In its Instrumentation and Control Div. Ann. Progr. Rept., for Period Ending Sep. 1, 1965 Aug. 1966 p 44–52 refs (See N67-19423 09-14) CFSTI: HC $3.00/MF $0.65

Basic scientific instrumentation for detection of ionizing particles and radiation are briefly evaluated. Sixteen lithium-drifted germanium detectors with active volumes up to 6 cm^3 demonstrated excellent stability in field use over periods up to 18 months. For use in high-resolution, gamma-energy spectrometers, improved detectors were produced with a lithium-drift depth of 7 mm and a resolution of less than 6 keV for ^{60}Co gammas. Technical details are also presented on: alpha scintillation detector response in gamma-ray and neutron backgrounds, ion-chamber current fluctuations produced by neutron and gamma sources, PCP III ionization chamber, spherical BF_3 proportional counters, and radiation damage in cadmium sulfide and cadmium telluride.
R.Li.

N67-19432# Oak Ridge National Lab., Tenn.
RADIATION MONITORING

In its Instrumentation and Control Div. Ann. Progr. Rept., for Period Ending Sep. 1, 1965 Aug. 1966 p 53–62 refs (See N67-19423 09-14) CFSTI: HC$3.00/MF$0.65

Several phases of the operation and maintenance of radiation warning and monitoring systems are briefly outlined. Performance, modernization and expansion of this communication network are sketched, and a schematic summary of the existing and proposed laboratory radiation control system presented. Such monitoring systems are in application to: waste effluents, environment, radio communication, emergency public address system, and closed-circuit TV. R.Ll.

N67-19433# Oak Ridge National Lab., Tenn.
DEVELOPMENT OF INSTRUMENTS AND COMPONENTS
In its Instrumentation and Control Div. Ann. Progr. Rept., for Period Ending Sep. 1, 1965 Aug. 1966 p 63–74 refs (See N67-19423 09-14) CFSTI: HC$3.00/MF$0.65

For radiation protection application, instrumentation and component development progress is reported on: reactor cladding-failure detector, shoe contamination monitor, stack effluent monitor for alpha radiation, gamma process monitor, thermal-neutron survey meter, alpha survey meter, compacted ^{10}B absorbers, remotely operated low-energy neutron spectrometer, and detector for radioactive-gas monitor. Also noted is an investigation of a type CD-V-742 dosimeter failures. An alpha monitor for heavy-element chemistry is briefly described. Graphics complete the technical details. R.Ll.

N67-19435# Oak Ridge National Lab., Tenn.
PROCESS INSTRUMENTATION AND CONTROL SYSTEMS ENGINEERING
In its Instrumentation and Control Div. Ann. Progr. Rept., for Period Ending Sep. 1, 1965 Aug. 1966 p 91–100 refs (See N67-19423 09-14) CFSTI: HC$3.00/MF$0.65

For reactor technology utilization, process instrumentation and control systems engineering activities are reported in several technical areas. Specification, design, procurement, installation, and testing continued in the thorium utilization program. Instrumentation was installed for a ^{233}U liquid storage facility. Transuranium processing plant valves and instrumentation work advanced. Brief consideration is also given to the nuclear safety pilot plant, the start up of a high-radiation-level analytical laboratory, a containment research installation, and project Salt Vault. Also depicted is a system for thermocouple scanning and overtemperature control. R.Ll.

N67-19436# Oak Ridge National Lab., Tenn.
PROCESS INSTRUMENTATION DEVELOPMENT
In its Instrumentation and Control Div. Ann. Progr. Rept., for Period Ending Sep. 1, 1965 Aug. (See N67-19423 09-14) CFSTI: HC$3.00/MF$0.65

Summarized technical details are presented on process instrumentation development for temperature sensors and improved thermocouples, as a part of a continuing reactor technology research program. Graphs show the thermal emf drift tests on tungsten–rhenium alloy thermocouples in argon atmospheres, average drift of W–Re alloy thermocouples at constant temperature, and error of chromel-P–Alumel thermocouples and platinum resistance thermometers. A circuit was developed for linearizing the output of Pt vs Pt–10% Rh thermocouples, with an accuracy of ±3°C and a range from 200° to 1400°C. Also briefly outlined are: thermal emf of three types of thermocouple lead–wire connectors, thermocouple-scanner reference voltage supply, differential thermal analysis system, temperature measurements by infrared methods, nozzle flow stability in pneumatic temperature measurements, and an experiment simulator for high-temperature fuel studies. R.Ll.

N67-19437# Oak Ridge National Lab., Tenn.
LEVEL OF MOLTEN METAL AND MOLTEN SALT
In its Instrumentation and Control Div. Ann. Progr. Rept., for Period Ending Sep. 1, 1965 Aug. 1966 p 114–122 refs (See N67-19423 09-14) CFSTI: HC$3.00/MF$0.65

An inductive-type detector was developed for measuring the level of molten metal and molten salt. Graphics depict the level transducer, detector system and recorder output. Briefly highlighted are: the design, fabrication, and testing of a resistance-type continuous liquid-metal level indicator, called an I-tube, used for the continuous and accurate measurement of liquid level. A diagram shows the fuel storage tank ultrasonic level indicator system for molten salt. Also described are: the conductivity-type single-point level indicator for molten salt, and the float-type level transmitter for molten salt. R.Ll.

N67-19438# Oak Ridge National Lab., Tenn.
DIFFERENTIAL PRESSURE
In its Instrumentation and Control Div. Ann. Progr. Rept., for Period Ending Sep. 1, 1965 Aug. 1966 p 123 (See N67-19423 09-14) CFSTI: HC$3.00/MF$0.65

As part of a continuing program on instrumentation research, an investigation was made of the failure of one of the two NaK-filled differential-pressure transmitters installed in the coolant-salt system several days after the start of coolant-salt circulation. Testing was conducted to determine the cause of zero and span shifts and whether repair of the transmitter is feasible. Although inconclusive, results show that the zero shifts are predominantly temperature-induced, mechanical in nature, and not caused by the strain-gauge transducer or other electrical circuits. R.Ll.

N67-19439# Oak Ridge National Lab., Tenn.
TURBOPUMP SPEED
In its Instrumentation and Control Div. Ann. Progr. Rept., for Period Ending Sep. 1, 1965 Aug. 1966 p 123–124 (See N67-19423 09-14) CFSTI: HC$3.00/MF$0.65

To measure the rotational speed of a totally enclosed turbopump operating at high temperature in a potassium system, a new transducer was developed from a prototype model. At test cell temperatures above 125°F, the performance degraded rapidly until the induced ac pickup from the cell and equipment heaters completely obscured the speed signal. A second speed detector was developed for other programs where the same speed measuring problems existed for different turbine designs. Results are inconclusive, since testing of this detector only at room temperature is reported. R.Ll.

N67-19468* Arkansas Univ., Little Rock.
DYNAMIC MEASUREMENTS: TRANSDUCER CALIBRATION
V. E. Horn *In its* Invest. of Laser Properties Relevant to the Meas. of Different Phys. Parameters 31 Dec. 1966 p 48–53 refs (See N67-19461 09-16) CFSTI: HC$3.00

The feasibility of the interferometer method of measuring extremely small oscillatory motions such as those associated with the calibration of miniature accelerometers was demonstrated with a Michelson interferometer and a laser source. The lower limit of such measurement will finally be set by the noise created at the laser source. The best source available has approximately 1/4 of 1% amplitude modulation short term. This would allow a measurement of 20 angstroms with better than two-to-one signal-to-noise ratio which should be satisfactory for accurate measurement. However, there are a number of drift and stability considerations that must be understood before the noise of the laser becomes the limiting factor. R.N.A.

N67-19624# Atomic Energy Commission, Washington, D.C.
THREE METALLOGRAPHIC OBSERVATIONS
E. L. Long, Jr. *In its* High Temp. Thermometry Mar. 1966 5 p ref (See N67-19621 09-22) CFSTI: HC$3.00/MF$0.65

Three metallographic examinations of commercial thermocouples which illustrate the complexity of the hot junction

system and problem areas of concern to thermocouple users, are reportad. Two differently sheathed thermocouples were exposed to graphite under a helium blanket for two cycles in the Oak Ridge Reactor (ORR). Thermocouple A was exposed at 900°C and was comprised of MgO insulated $Pt_{90}Rh_{10}$/Pt thermoelements sheathed with type 304 stainless steel; and thermocouple B was exposed at 750°C and was comprised of MgO insulated Chromel/Alumel thermo-elements sheathed in type 347 stainless steel which was copper plated prior to exposure. Metallographic analyses within 0.1 in of the hot junction indicated that the copper plating of stainless steel sheathed thermocouples appears to be an effective means to prevent carburization of the sheath when exposed to graphite and a means to avoid contamination of the atmosphere within the sheath. A third thermocouple (C) consisting of $W_{95}Re_5$/$W_{74}Re_{26}$ thermoelements insulated with BeO and sheathed in tantalum was tested at 1315°C. The only unusual microstructural change noted for this thermocouple was film about 0.2 mil thick at the inner surface of the tantalum sheath. The film was attributed to either an impurity in the tantalum reacting with the BeO or the tantalum reacting with impurities in the BeO. A broken tantalum tipped, stainless steel sheathed thermocouple was examined to determine the cause of failure of the tantalum-stainless steel juncture during placement in irradiation experiments. Failure was due to a fabrication technique. S.C.W.

N67-19626# Atomic Energy Commission, Washington, D. C.
THERMAL EMF DRIFT OF HIGH-TEMPERATURE THERMOCOUPLES IN HELIUM AND ARGON
N. H. Briggs and W. W. Johnston, Jr. *In its* High Temp. Thermometry Mar. 1966 3 p (See N67-19621 09-22) CFSTI: HC $3.00/MF $0.65

Tungsten–rhenium alloy and Pt–Rh alloy thermocouples insulated with crushed BeO and sheathed in 0.062-in.-OD were tested in a pure helium atmosphere. The initial thermal emf drift was equivalent to about 15°C for the W–Re alloys in the first few hours of testing, after which the drift was within the precision of the temperature measurement (−10°C). The Pt–Rh alloy thermocouples did not drift appreciably. Results of failure analyses and insulation resistance measurements are discussed. Two W-3% Re/W-25% Re and two W-5% Re/W-26% Re thermocouples were tested in argon at 3475 to 3490°F. The drift of all four thermocouples was approximately 5°F in the first 235 hr. In the second period, the total drift was approximately 25°F for the W-3% Re/W-25% Re thermocouple and approximately 15°F for the W-5% Re/W-26% Re thermocouples. Two tantalum sheathed, BeO insulated, 0.068-in.-OD thermocouples (TC-1 and TC-2) with 0.010-in.-OD, W-5% Re/W-26% Re wires were calibrated to 3800°F, and their drift at 3400°F was measured for approximately 120 hr. Results showed that TC-1 was less accurate than TC-2. Differences in calibration curves of the two thermocouples were attributed to the breakdown in insulation resistance of TC-1 at high temperatures. The drift of TC-1 at 3400°F over a 120-hr period was greater than that of TC-2. Values obtained were −75°F for TC-1 versus −15°F for TC-2. S.C.W.

N67-19627# Atomic Energy Commission, Washington, D. C.
THERMAL EMF DRIFT OF REFRACTORY METAL THERMOCOUPLES IN PURE AND SLIGHTLY CONTAMINATED HELIUM ATMOSPHERES
R. L. Bennett, H. L. Hemphill, and W. T. Rainey, Jr. *In its* High Temp. Thermometry Mar. 1966 2 p (See N67-19621 09-22) CFSTI: HC $3.00/MF $0.65

Results of thermoelectric stability tests of tungsten vs tungsten-26% rhenium thermocouples in pure and slightly contaminated helium atmospheres are reported. Bare tungsten vs tungsten-26% rhenium thermocouples were found to be stable thermoelectrically at 1750°C in pure helium. Tests of tungsten, tungsten-5% rhenium, tungsten-26% rhenium, rhenium, and iridium-60% rhodium were made in a helium atmosphere containing 100 ppm of CO at 1750°C. Large drifts in the emf of the W/W-26% Re couple were observed. A change of about +3.0 mv (180°C) in 90 hr was typical for thermocouples made of 0.020-in wire. Smaller wire (0.010 in) changed more rapidly (−7.0 in 24 hr). The emf outputs of rhenium and iridium-60% rhodium were not appreciably changed by exposure under these conditions. After 50 to 75 hr exposure of 0.010-in. wires, the following couple drifts were noted: W vs Re, −2.4 mv; W-5% Re vs W, −6.0 mv; W vs W-26% Re, −3.5 mv; W-5% Re vs W-26% Re, −2.5 mv. Drift rates with 25 ppm CO in the helium atmosphere were approximately the same as with 100 ppm. Exposures to the He-100 ppm CO at lower temperatures (1370°C) showed similar results at reduced rates. Tungsten and tungsten-5% rhenium wires were thermoelectrically stable at temperatures below about 1150°C in the same atmosphere. Results of studies of tungsten vs tungsten-26% rhenium couples in flowing helium atmospheres containing low oxygen concentrations are also reported. S.C.W.

N67-19629# Atomic Energy Commission, Washington, D. C.
HIGH-TEMPERATURE HIGH-VACUUM THERMOCOUPLE DRIFT TESTS
J. W. Hendricks and D. L. McElroy *In its* High Temp. Thermometry Mar. 1966 26 p refs (See N67-19621 09-22) CFSTI: HC $3.00/MF $0.65

Results of drift tests of four types of high temperature thermocouples insulated with pretreated two-hole ΔRR alumina sheaths are reported. Described is a drift test facility which was designed to allow extended testing at temperatures up to 1500°C at pressures below 10^{-6} torr. Tests at 1200 to 1450°C for times up to 1000 hr at pressures between 10^{-6} and 10^{-8} torr showed that the thermal emfs for platinum–rhodium- and tungsten–rhenium-base thermoelements did not drift under these conditions. Commercially available thermocouples of the type $Pt_{90}Rh_{10}$/Pt, $Pt_{94}Rh_6/Pt_{70}Rh_{30}$, $W/W_{74}Re_{26}$, and $W_{95}Re_5$/$W_{74}Re_{26}$ were stable within −10°C for the test conditions. Wire size and alloy content did not affect the stability in these tests. Post-test examinations revealed only minor surface appearance changes for the stable thermocouples. A test at 1450°C showed that drift of thermal emf could be expected in $Pt_{94}Rh_6/Pt_{70}Rh_{30}$ thermocouples if the hot junction is joined to niobium and exposed to a severe temperature gradient. This drift is attributed to compositional inhomogeneities due to diffusion of niobium into the hot junction. Several thermal emf changes were observed at 1200°C in tantalum- and niobium-sheathed, MgO insulated $Pt_{90}Rh_{10}$/Pt thermocouples. It is surmised that these changes were apparently caused by a reaction between the thermoelements and MgO. S.C.W.

N67-19630# Atomic Energy Commission, Washington, D. C.
INFLUENCE OF CO–CO_2 ENVIRONMENTS ON THE CALIBRATION OF CHROMEL–P–ALUMEL THERMOCOUPLES
H. E. McCoy, Jr. *In its* High Temp. Thermometry Mar. 1966 18 p refs (See N67-19621 09-22) CFSTI: HC $3.00/MF $0.65

The drift rate of a 20 gauge (0.032 in) Chromel-P-Alumel thermocouples exposed to flowing CO_2 for 1000 hr are tabulated. that the thermal output of the exposed thermocouple decreased such that after 650 hr the furnace temperature was at 1000°C in order to supply the controller with a 34.1 mv signal. Carbon analyses showed that both wires contained greater than 5 wt % C near the hot junction. Metallographic analyses near the hot junction showed that the Alumel wire was internally oxidized throughout the entire cross section and that the Chromel wire was heavily oxidized and a grain boundary precipitate (chromium carbide) was formed. Three 24-guage (0.020 in) Chromel-P-Alumel thermocouples were tested at 650, 750, and 850°C in flowing 95 vol % CO_2-5 vol % CO. The thermocouple at 650°C showed a positive drift which reached a value of 10°C after 2500 hr. At 750°C an initial positive calibration shift equivalent to about 18°C was observed which continued to a maximum value of 19°C in

80 hr. At 850°C the thermocouple drifted negatively throughout the test. Metallographic analyses showed that at 650°C both wires were oxidized appreciably; at 750°C the Chromel-P wire was internally oxidized throughout and the Alumel wire was uniformly oxidized to a depth of 1.5 mils; and at 850°C both wires were internally oxidized throughout. Data on three 20 gauge thermocouples exposed to flowing CO_2 for 1000 hr are tabulated. In a similar test it was found that in 257 hr the output of these three thermocouples drifted such that the indicated temperature changed from 833 to 753°C, from 722 to 714°C, and from 620 to 611°C. S.C.W.

N67-19631# Atomic Energy Commission, Washington, D. C.
CONTAMINATION OF PLATINUM–RHODIUM TRANSDUCERS
J. P. Moore and D. L. McElroy *In its* High Temp. Thermometry Mar. 1966 3 p (See N67-19621 09-22) CFSTI: HC $3.00/MF $0.65

Contamination effects which caused 90°C discrepancies in core heater resistance of $Pt_{90}Rh_{10}/Pt$ thermocouples during thermal conductivity measurements of Inconel 702 are discussed. Inspection of the system revealed: (1) The granular Al_2O_3 in the annulus between the core heater and the Inconel 702 was black; (2) The Inconel 702 was slightly oxidized; and (3) The surface appearance of the $Pt_{94}Rh_6$ core heater wire and the $Pt_{90}Rh_{10}/Pt$ thermocouple wires near the Inconel 702 was mottled. The core wire was analyzed and found to contain Al, Si, Ca, and Mg; the latter three of which are the major impurities in the granular Al_2O_3. Data from new thermocouples placed on one plane of the Inconel 702 indicated that the 90°C discrepancy is due to changes in both the core heater resistance and the thermocouple emf. Further evidence of this phenomenon which was observed during the operation of an adiabatic calorimeter is cited. It is suggested that the use of Pt–Rh thermocouples insulated with Al_2O_3 near Inconel systems be avoided until definitive tests are made. S.C.W.

N67-19635# Sandia Corp., Albuquerque, N. Mex.
MEASUREMENTS OF HIGH TEMPERATURES
J. A. Barber *In* AEC High Temp. Thermometry Mar. 1966 30 p refs (See N67-19621 09-22) CFSTI: HC $3.00/MF $0.65

Inherent problems associated with the use of woven insulation thermocouples and metal sheathed thermocouples for high temperature measurements are discussed. Characteristic problems of woven insulation thermocouples were lack of mechanical strength and quality control; marked differences in quality of insulation; and rapid deterioration or melting of the insulating material surrounding the thermocouple wires. Below the softening points of platinum and stainless steel, metal sheathed thermocouples show good results. Above the softening points, these thermocouples exhibit rapid oxidation of sheath material, are generally unusable for more than one test; are either highly radioactive or toxic (thorium oxide); and combine with carbon to become carbides at relatively low temperatures. Attempted solutions to these problems have included: the use of ceramic oxides as melt sensors to measure limited ranges of temperatures; the use of water cooled sensors for continuous measurement of flux rates up to 500 BTU/ft^2 sec; and the use of cooled and uncooled calorimeters. S.C.W.

N67-19636# Naval Research Lab., Washington, D. C.
INSTABILITY OF NOBLE METAL AND REFRACTORY METAL THERMOCOUPLES FROM 1000°C TO 1700°C
B. E. Walker, Jr. *In* AEC High Temp. Thermometry Mar. 1966 31 p refs (See N67-19621 09-22) CFSTI: HC $3.00/MF $0.65

The instability of noble metal and refractory metal thermocouples was studied to determine factors which influence stability and to provide information to allow predictions of the reliability of particular thermocouples under specified conditions. Noble metal thermocouples which included combinations of Pt, Pt–Rh alloys, Ir, and Ir–Rh alloys were studied in oxidizing, neutral, and vacuum atmospheres from 1000 to 1700°C. Refractory metal thermocouples which included combinations of W, Re, Ta, Mo, and alloys of these metals were restricted to inert atmospheres and vacuum. Analyzed are instabilities caused by contamination by furnace atmosphere and ceramic protection tubes, exchange of alloying elements at welded junctions, preferential volatilization of one metal or oxide from an alloy leg, and temperature induced transitions in the thermoelements. Criteria useful in identifying and controlling sources of error which may be encountered when using noble metal and refractory metal thermocouples at high temperatures are included. S.C.W.

N67-19637# Battelle Memorial Inst., Columbus, Ohio.
CONTRIBUTION TO THE MEETING ON HIGH-TEMPERATURE THERMOMETRY
G. W. Cunningham and W. H. Goldthwaite *In* AEC High Temp. Thermometry Mar. 1966 14 p refs (See N67-19621 09-22) CFSTI: HC $3.00/MF $0.65

Summarized are in-pile high temperature thermometry research. Cited are specifications and handling procedures for W-5 Re vs W-26 Re thermocouples sheathed with Nb-1Zr alloy; thermodynamic studies of MgO compatibility; studies of tungsten-26 rhenium thermocouple wire stability; observations of the performance of high temperature in-pile thermocouples; studies of the applicability of platinum-rhodium thermocouples in oxidizing atmospheres; calculations of the effect of transmutation on the thermopower of tungsten-tungsten 26 rhenium thermocouples; and efforts to develop a differential thermal analysis unit for measuring phase changes at temperatures to 2700°C. S.C.W.

N67-19641# Pratt and Whitney Aircraft, East Hartford, Conn.
HIGH TEMPERATURE THERMOMETRY AT CANEL
P. Bliss *In* AEC High Temp. Thermometry Mar. 1966 11 p (See N67-19621 09-22) CFSTI: HC $3.00/MF $0.65

Summarized are research focusing on the design, fabrication, and quality control, of thermocouples for high temperature applications. Fabrication techniques used in the development of a non-grounded Chromel/Alumel thermocouple which was designed to measure temperatures up to 2200°F for 10,000 hours inpile, are described. Materials studies indicate that alumina, if pure, is compatible with Chromel, Alumel, molybdenum, columbium, and the alloys of tungsten and rhenium, at temperatures to 2200°F for 10,000 hour periods. Contamination problems which were encountered while using refractory metal sheathed thermocouples during inpile and out of pile tests are discussed. Also discussed are efforts to develop a radiation resistant thermoelectric pair for temperatures up to 2600°F which is compatible with a columbium sheath and suitable for vacuum, gas, and lithium environments; and the development of methods for predicting the decalibration effect on transmutation. S.C.W.

N67-19645# National Lead Co. of Ohio, Cincinnati.
MEASUREMENT OF REMELT FURNANCE POUR TEMPERATURES BY INFRARED PYROMETRY
J. A. Williamson *In* AEC High Temp. Thermometry Mar. 1966 6 p refs (See N67-19621 09-22) CFSTI: HC $3.00/MF $0.65

Results of studies to determine the feasibility of using infrared pyrometers for measuring the temperature of molten uranium in remelt furnaces and thereby control the temperature at which the uranium is poured into ingot molds, are reported. A Thermodot Model TD-6B infrared pyrometer was tested using a Stokes vacuum remelt furnace. The emissivity of the graphite pour plug and of the molten uranium stream was determined. The first of two tests indicated that at an average melt temperature of 2600°F the average plug temperature was 2080°F. Emissivity values of 0.82 for the pour plug and 0.50 for the pour stream were also determined. Test data indicated that it is feasible to predict the pour stream temperature by measuring the pour plug temperature. The second

test established that the heating cycle could be controlled by the infrared pyrometer reading. Testing of infrared pyrometers was extended to production operations and used to measure the melting point of copper in production furnaces. The pyrometer repeatedly gave the same reading for the melting point of copper. Although there were more uncontrolled variables which influenced the melting temperature in these furnaces, it is surmised that the infrared pyrometer holds considerable promise as a means of measuring the remelt pour temperatures on a routine production basis. S.C.W.

N67-19646# Brookhaven National Lab., Upton, N. Y.
STABILITY OF A RHENIUM-GRAPHITE THERMOCOUPLE
F. J. Salzano *In* AEC High Temp. Thermometry Mar. 1966 9 p refs (See N67-19621 09-22) CFSTI: HC $3.00/MF $0.65

The stability of a thermocouple fabricated from rhenium metal and graphite was investigated from 800°C to 2200°C. Some drift in the emfs vs temperature curve resulted from the diffusion of carbon into the rhenium at high temperatures. The drift in emf after 30 hours at 2200°C was equivalent to −75°C. It is suggested that a stable thermocouple can be prepared using a rhenium-carbon alloy and graphite. Author

N67-19664# Institute of Modern Languages, Inc., Washington, D. C.
TEST RESULTS ON GYROTHEODOLITES
Yu. V. Sergovskiy Ft. Belvoir, Va., Army Eng. Res. and Develop. Labs., Oct. 1966 9 p Transl. into ENGLISH from Geodez. i Kartograf. (Moscow), v. 1, 17–20 Jan. 1966
(Contract DA-44-009-AMC-1563(T))
(ERDL-T-1874-66; TT-66-62539; AD-641274) CFSTI: HC $3.00/MF $0.65

Test operation of the instruments have shown that: (1) The Gi-B1 gyrotheodolites, which are produced in Hungary, provide for autonomous determination of the azimuths of orienting directions with a mean-square error of + 20 sec within 40-60 minutes. (2) The instrument is easy to handle and is simple to operate. The majority of the instruments function flawlessly and yields reliable results; however, some of them do not provide for stability of the constant correction of the instrument. Drawbacks in the design of the instruments are the lack of automatic tracking of the position of the resection points, as well as the long time (up to 90 minuts) required for the power pack to warm up when operating under low-temperature conditions. To date field tests on two experimental models of the Gi-B2 gyrotheodolite have been carried out. Out of 139 runs by these instruments, carried out over a period of 20 days at latitudes of 45-60 deg, the mean-square error in determining the direction from one run was equal to about + 10 sec. In the course of transporting the instrument about 3000 km by motor vehicle and about 2000 km in an aircraft, no changes were detected in the rated value of the constant correction. Chilling them twice to temperatures of -30 and -40C did not lead to a reduction in their operating precision. Author (TAB)

N67-19680# Institute of Modern Languages, Inc., Washington, D. C.
PHOTOGRAMMETRIC PLOTTING INSTRUMENTS
Marchik Shanak Ft. Belvoir, Va., Army Eng. and Develop. Labs., Oct. 1966 18 p Transl. into ENGLISH from Geodeticky a Kartograficky Obzor (Prague), no. 12/54 p 45–48
(Contract DA-44-009-AMC-1563(T))
(ERDL-T-1878-66; T-66-62542; AD-641276) CFSTI: HC $3.00/MF $0.65

The instruments described include the stereotrigomat equipped with a differential transposing device, the universal plotting instrument used in precise aerial triangulation, graphic and numerical plotting, and in achieving transposed photos of a hilly terrain; and the analytical plotting instrument AP-C. TAB

N67-19758# IIT Research Inst., Chicago, Ill.
CONTINUOUS FACSIMILE SCANNER EMPLOYING FIBER OPTICS Quarterly Report, 1 Jan.–31 Mar. 1966
Donald A. Pontarelli Jul. 1966 16 p refs
(Contract DA-28-043-AMC-00164(E))
(QR-7; IITRI-A6093-21; ECOM-00164-7; AD-643075) CFSTI: HC $3.00/MF $0.65

Mechanical design features of the prototype facsimile scanner are listed and discussed in some detail. This phase of the program is estimated to be approximately 80% completed. The fiber optics detector system, consisting of a light source detector and modulator circuit, is approaching finalization. Problem areas in this phase are discussed. Author (TAB)

N67-19773# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
CERTAIN QUESTIONS OF THE INCREASING INTERPRETATION PROPERTIES OF AERIAL PHOTOGRAPHS
V. I. Narkevich 31 Aug. 1966 27 p refs Transl. into ENGLISH from the publ. "Kompleksnoye Deshifrirovaniye Aerosnimkov" Moscow, Izd. Nauka, 1964 p 12–23
(FTD-MT-65-242; TT-67-60236; AD-643896) CFSTI: HC $3.00/MF $0.65

Contents: Features of construction of the photographic image in aerial photography; Image shifts caused by the forward motion and angular oscillations of the aircraft; Image shifts caused by vibrations of the aircraft and operation of mechanisms of the aerial camera; Effect of the positive process; Criteria for appraisals and control; State of the art and prospects; Informational properties of aerial photographs. TAB

N67-19781# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
PULSE VOLTMETER
Ye. A. Bobkov and V. V. Sazonov 16 Sep. 1966 6 p Transl. into ENGLISH from Russian Patent No. 171031 (Appl. No. 834989/26-9, 10 May 1963) 2 p
(FTD-HT-66-101; AD-644641) CFSTI: HC $3.00/MF $0.65

The object of the invention is a pulse voltmeter for measuring the strength of the voltage of nanosecond pulses, which contains a DC instrument and a system of automatic regulation of the position of the pulses to be measured on the screen of an oscillograph. For the purpose of improving the precision of the measurements by means of decoupling the pulses to be measured and the measuring circuit and also removing the influence of the thickness of the line of scanning of the oscillograph on the results of the measuring as a pickup of the unbalance there is used a photoelectronic multiplier with a slotted shield set up at the screen of the oscillograph for bringing together the top of the image (or edge of line of scanning) with the edge of the slot with automatic feed of direct compensation voltage onto the plate of the vertical deflection of the oscillograph. Author (TAB)

N67-19898* Sperry Gyroscope Co., Great Neck, N. Y.
STUDY OF METHODS FOR SYNCHRONIZING REMOTELY-LOCATED CLOCKS Final Report, Jul. 1965–Aug. 1966
Washington, NASA, Mar. 1967 220 p refs
(Contract NAS5-9905)
(NASA-CR-738) CFSTI: $3.00 CSCL 14B

Time scale functions, the characteristics of radio propagation, frequency standards, and portable clocks are discussed. The characteristics of currently available or proposed time synchronization systems in all major frequency bands are surveyed, as well as those of line-of-sight and satellite systems. Fundamental consideration of time synchronization are reviewed in detail and the design for an OMEGA timing receiver is fully discussed. The choice of a practical clock synchronization system is determined by three basic

considerations: (1) the synchronization accuracy desired, (2) the size of the area within which synchronization is to be implemented, and (3) the relative accessibility of the remote clocks to the receipt of synchronizing data within their area. As the accuracy requirement is increased, the cost rises proportionately due to greater system complexity, operational costs, and synchronization logistics. With the present trend towards ever-increasing area coverage and greater separation between clocks, many of the candidate synchronization systems cannot meet the new requirements. In the area of accessibility, the problems of signal transmission through varying media also exclude the use of certain techniques. A Slave clock set once by a Master clock and stabilized by reference to VLF signals is recommended. Good accuracy and relatively low cost will both be achieved in such a system. Author

N67-19897* North American Aviation, Inc., Los Angeles, Calif.
THE DESIGN, FABRICATION AND FEASIBILITY TESTING OF A PROTOTYPE AIRBORNE RESPIRATION ANALYZER
R. K. Breeze and G. N. Campbell Washington, NASA, Mar. 1967 111 p refs
(Contract NAS4-966)
(NASA-CR-741) CFSTI: $3.00 CSCL 06B

A test program was conducted which demonstrated the feasibility of a prototype airborne respiration analyzer to measure human respiration products and oxygen consumption within ±10% using equipment compatible with aerospace crew compartments and associated environments. The program also proved the effectiveness of single sensors to measure both inspired and expired gases within ±1%, and of small mixing chambers to remove the breath-by-breath fluctuation of gas compositions to be compatible with these accuracies. These abilities were demonstrated over an altitude range from sea level to 15,000 ft. R.N.A.

N67-19905* California Univ., Berkeley. School of Forestry.
THE USE OF HIGH ALTITUDE COLOR AND SPECTROZONAL IMAGERY FOR THE INVENTORY OF WILDLAND RESOURCES. VOLUME I: THE TIMBER RESOURCE
David M. Carneggie, William C. Draeger, and Donald T. Lauer 30 Sep. 1966 78 p refs
(NASA Order R-09-038-002)
(NASA-CR-82963) CFSTI: $3.00 CSCL 02F

High altitude multispectral imagery of a large wildland area was studied to determine the ease and accuracy of identifying and mapping those terrain features which aid in the inventory or evaluation of timber production, planting sites, harvesting, and forest protection. Photo interpretation keys for identifying important terrain features associated with the timber resource were prepared for four principal image types. A feasibility table summarizes the ease of using the separate image types for identifying wildland terrain features. No single film-filter combination or image type interpreted is best suited for identifying or mapping all terrain features. More information can be obtained from interpretation of two or more spectral bands in concert. Ekta–Aero infrared film is the most useful single film-filter combination for inventorying the greatest variety of terrain features when interpreting small scale photography. However, large scale Aerial Ektachrome photography was as accurate as the Ekta–Aero infrared for identifying individual tree species. Thermal infrared imagery can distinguish differences in timber density and K-band radar imagery can map gross vegetation boundaries and topographic features within watersheds. Author

N67-19914*# Parametrics, Inc., Waltham, Mass.
ULTRASONIC TEMPERATURE MEASURING DEVICE
Quarterly Progress Report
L. C. Lynnworth and E. H. Carnevale Jan. 1967 12 p
(Contract NAS3-7981)
(NASA-CR-72157; QPR-6) CFSTI: HC $3.00/MF $0.65 CSCL 20M

Rhenium wires, previously irradiated to 8.7×10^{19} integrated thermal flux and 2.6×10^{19} integrated fast flux, were annealed and ultrasonically tested in vacuum up to ≈4000°R, together with nonirradiated rhenium control wires. Sound velocities were measured during heating and cooling. These control wire and irradiated wire velocity data exhibited no significant systematic differences. Structural or compositional radiation effects due to the radiation levels were negligibly small. The scatter in these velocity data corresponds to uncertainties in ultrasonically determined temperatures as follows: near 2000°R, ±2%; near 3000°R, ±1%; near 4000°R, less than ±1%. Two nonirradiated rhenium wires, one annealed and one not annealed, were tested while being heated up to ≈5500°R. Up to 4000°R, i.e., before the second wire became annealed, the two ultrasonically indicated temperatures differed as follows: near 2000°R, 10%; near 3000°R, 8.5%; near 4000°R, 2.5%. Above 4000°R, annealing brought the two ultrasonically indicated temperatures into closer agreement: near 5000°R, 1/2%; near 5350°R, better than 1/2%. Author

N67-19919*# General Precision, Inc., Little Falls, N. J. Materials Dept.
THERMOCHROMIC DISPLAY MATERIALS FOR USE UNDER WIDE VARIATIONS IN AMBIENT ILLUMINATION LEVELS
Annual Progress Report, 1 Dec. 1965–30 Nov. 1966
Raymond P. Borkowski, Lies N. Finnie, Marvin J. Kombiau, and Daniel Grafstein 31 Jan. 1967 82 p refs
(Contract NAS12-89)
(NASA-CR-80016; APR-1) CFSTI: HC $3.00/MF $0.65 CSCL 05H

Results are presented on the first phase of an investigation of the feasibility of using thermochromic materials in display devices. These materials change color when heated and revert back to their original color when cooled. The observation of the color change depends on the change in reflection and not on the emission of light, as is the case in electroluminescent materials. Thus, displays utilizing thermochromic materials are visible under wide ranges of ambient illumination. Prototype numerical display devices were constructed in which two of the known thermochromic compounds, silver mercuric iodide and copper mercuric iodide, were used as the display materials. These prototypes gave high contrast images and demonstrated the feasibility of using these materials in devices of this kind. Two potential device applications considered included using thermochromic materials along with electroluminescent phosphors in an hybride device, and as a substitute for the phosphor in a cathode ray tube. Various new thermochromic materials were synthesized. These included substitutional formulations of the known thermochromic ternary iodides and certain ternary chalcogenides. Some of the more important properties of these thermochromic materials such as their transition temperature, reflectance spectra, thermal stability, and electrical conductivity were determined. Author

N67-19922* Nuclide Corp., State College, Pa.
DEVELOPMENT OF A MASS SPECTROMETER SYSTEM FOR THE IN-FLIGHT ANALYSIS OF THE LUNAR ATMOSPHERE
L. F. Herzog, R. Buchanan, and S. R. Gryczuk Dec. 1966 55 p refs
(Contract NASw-1286)
(NASA-CR-82968) CFSTI: HC $3.00 CSCL 20F

A monopole and time-of-flight (TOF) mass spectrometer were selected as having the greatest potential for the proposed experiment and a breadboard instrument of each type of moderate resolution and mass range was built and tested. The results of this work indicate that both instruments have adequate sensitivity and resolution to detect and separate the major atmospheric constituents, based on current estimates of the total atmospheric

pressure and postulated atmospheric composition. The two instruments were built to investigate and compare their operating characteristics and no attempt has yet been made to minimize weight and power consumption. Indications are, however, that either instrument could be built in a form suitable for extraterrestrial mission applications. Performing the analysis of the atmosphere continuously while a probe approaches the lunar surface offers the possibility of obtaining a height profile of its composition, and the spectrometer is automatically kept from surface contamination. A spectrometer placed on the moon by an un-manned vehicle lacks these advantages but has the capability of measuring variations in composition that occur as a function of time. Author

N67-19939* California Univ., Berkeley. School of Forestry.
THE USE OF HIGH ALTITUDE, COLOR AND SPECTROZONAL IMAGERY FOR THE INVENTORY OF WILDLAND RESOURCES. VOLUME III: THE SOIL, WATER, WILDLIFE AND RECREATION RESOURCE
David M. Carneggie and Robert N. Colwell 30 Sep. 1966 97 p
(NASA Order R-09-038-002)
(NASA-CR-82973) CFSTI: HC $3.00 CSCL 02C

High altitude multispectral imagery of a large wildland area in the Sierra Nevada Mountains in California, was studied to determine the ease and accuracy of identifying and mapping important wildland resources. Keys for identifying terrain features, which are associated with each resource, based on their photo image characteristics were prepared for each image type. A feasibility table is presented which summarizes the ease of using the image types tested for identifying wildland and terrain features. Ekta–Aero infrared film appears to be the most useful single film-filter combination for inventorying the greatest variety of terrain features found in a wildland area. Thermal infrared imagery appears to be useful for detecting distinct moisture conditions in meadow ranges and may prove to be a valuable tool for inventorying numbers of wildlife and cattle. K-band radar imagery appears to be useful for inventorying gross watershed characteristics. Author

N67-19946* ITT Industrial Labs., Fort Wayne, Ind.
A DAY-NIGHT HIGH RESOLUTION INFRARED RADIOMETER EMPLOYING TWO-STAGE RADIANT COOLING Quarterly Report, 24 Jun.–1 Oct. 1966
R. V. Annable, H. A. Leiter, J. F. Lodder, and D. J. Juarez 15 Oct. 1966 82 p refs
(Contract NAS5-10113)
(NASA-CR-82953; ITTIL-66-1051; QR-2) CFSTI: $3.00 CSCL 20F

This report covers the start of construction and testing of a two-stage radiant cooler to be used in a 10 to 12.2 micron Day-Night High Resolution Infrared Radiometer. It contains a description of the reduction in basic cooler dimensions and an outline of the mechanical design and construction of the initial test model of the cooler. A list of required test equipment is given together with its packaging configuration. Changes in thermal design of the cooler are reported, and, finally, effort in the area of optical design is covered. Author

N67-19975# Royal Aircraft Establishment, Farnborough (England).
THE DRIFT OF AN AUTO-PILOT GYROSCOPE DUE TO PROLONGED ACCELERATION IN THE SKYLARK ROCKET. PART 4: RESULTS FROM SKYLARKS SL31/32 AND GENERAL CONCLUSIONS FROM PROGRAMME
F. R. Knott Apr. 1966 50 p refs
(RAE-TR-66133)

The attitude of skylark rockets SL31/32 during flight, obtained from gyroscopes, radio-interferometers, and a photographic method is given. Gyro drift determined by comparing missile attitude from the gyroscopes with the attitude derived from interferometer data is then given. Drift rates obtained from this information are compared with preflight test results so that "in-flight" drift rates can be predicted. General conclusions are also given, based on data from twelve gyroscopes. Author

N67-20148# California Univ., Livermore. Lawrence Radiation Lab.
A PERSONNEL RADIATION DOSIMETER WITH STORAGE FOR PRESET ALARM AND CONTINUOUS READOUT
R. Lakin 17 Oct. 1966 12 p refs Presented at 13th Ann. Nucl. Sci. Symp., Boston
(Contract W-7405-ENG-48)
(UCRL-14925-T; CONF-661020-5) CFSTI: HC $3.00/MF $0.65

The circuit design of a gamma radiation dosimeter is described, which permits continuous monitoring of accumulated radiation dosage. An electrochemical integrating and storage device permits continuous readout in Roentgens followed by a preset audible alarm with an exponential horn tuned for maximum audio output with minimum power input. Any radiation dose rate can be monitored by selecting a G-M detector that gives the desired range. The unit described has a readout to 200 R and will operate in a radiation field up to 1000 R/hr with an accuracy to within ±5% in an operating temperature range from 0° to 60°C. The unit weighs less than one pound and has the capability to be clipped to the user's belt, allowing freedom of activity during emergency rescue operations or other hazardous assignment. Author (NASA)

N67-20179# United Kingdom Atomic Energy Authority, Harwell (England).
STUDY OF DIGITAL CONVERSION OF PHOTOGRAPHIC INFORMATION IN THE COLLEGE DE FRANCE HPD APPARATUS
G. Banasik, M. Bloch, and C. Guignard (College de France, Paris) Apr. 1966 28 p refs In FRENCH and ENGLISH
(NP-TR-1413; FSD-66-1)

The HPD system is one that enables quick and accurate measurements of bubble chamber photographs. The principle of photograph measurement is described. The track center determination circuits are also described. NSA

N67-20220# Japan Atomic Energy Research Inst., Tokyo.
METHOD FOR MEASURING VOID FRACTION BY ELECTROMAGNETIC FLOW METERS
Masao Hori, Tetsuo Kobori, and Yoshihiro Ouchi Aug. 1966 35 p refs
(JAERI-1111) CFSTI: HC $3.00/MF $0.65

An electromagnetic void meter, developed for studies of gas-liquid two-phase flows is described. Calibration experiments have been completed, using argon-mercury and air-water two-phase flows through a pipe. The results show that this method can be used for two-phase flows with a non-oscillatory flow pattern (bubble flow) without calibration, and with calibration for the oscillatory flow pattern (slug flow). This method may be applicable to two-phase flows in more complex shaped channels and in boiling conditions. Author (NSA)

N67-20253*# Sperry Gyroscope Co., Great Neck, N. Y.
SCEPTRON (TM) Final Study Report, 6 Jun.–6 Oct. 1966
6 Oct. 1966 99 p refs
(Contract NAS8-2060)
(NASA-CR-82856; HB-9222-0243) CFSTI: HC $3.00/MF $0.65 CSCL 14B

The design feasibility of a 100 Hz fiber optic device capable of measuring the frequency spectrum of a complex mechanical input forcing function is demonstrated. In the intended application the device would be mounted on a structural member of a missile whose vibration spectrum is to be measured. The fiber optic device considered is basically a refinement of the vibrating reed frequency analyzer. Conclusions were derived involving the feasibility of

covering the .1 KHz to 20 KHz frequency range. The design objective frequency range of 100 Hz to 20,000 Hz must be covered with four separate arrays covering the ranges of 100 to 376 Hz, 376 to 1410 Hz, 1414 to 5320 Hz, and 5320 to 20,000 Hz. This is necessary in order to prevent higher mode excitation of the array fibers. Other conclusions were that manufacturing problems associated with arrays increase in order of increasing frequency, and that the high frequency array requires development of a part that will limit the fiber motion to a safe maximum value. It is recommended that the operating ranges, parameters, and limitations be carefully evaluated against missile operational conditions and requirements before broadband arrays are built. S.P.

N67-20255* Southern Research Inst., Birmingham, Ala.
DESIGN, FABRICATION AND CALIBRATION OF SIX IRIDIUM VERSUS IRIDIUM-60 RHODIUM THERMOCOUPLES Final Report
19 May 1965 43 p refs
(Contract NAS8-5196)
(NASA-CR-82853) CFSTI: HC $3.00 CSCL 20M

Six iridium versus iridium-60 rhodium thermocouple assemblies were designed, fabricated, and calibrated. The thermoelectric output of the wire was determined, and the effect of thermal cycling on emf stability was evaluated. After the first exposure, the emf-temperature characteristic was fairly reproducible. The thermocouples performed well in repeated exposures to an oxy-acetylene flame. The major disadvantage of this thermocouple was embrittlement of the wires after high temperature exposures. Author

N67-20271*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
AN ACOUSTIC WIND MEASURING TECHNIQUE
Wesley W. Bushman (Mich. Univ., Ann Arbor) and Orvel E. Smith *In its* Aero-Astrodyn. Res. Rev. No. 5 15 Oct. 1966 p 108–118 refs (See N67-20261 09-34)
(Contracts NAS8-11054; NAS8-20357)

An atmospheric wind measurement technique has been developed and used to measure wind profiles from ground to 85 km. The technique is an extension of the rocket grenade experiment using as its sound source, rather than a grenade, the acoustic noise of a rocket's exhaust. To determine the wind profile from this continuous sound source, a set of equations has been derived and applied to measurements made during the flights of several Saturn vehicles. The profiles agree well with concurrent measurements at lower altitudes (below 50 km.) and are consistent with atmospheric circulation observations at higher altitudes. A preliminary error analysis indicates that the technique can be used to make measurements of sufficient precision to be useful in engineering and meteorological studies. Author

N67-20272*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
GROUND WIND MEASUREMENTS AND ANEMOMETER RESPONSE
James R. Scoggins and Dennis W. Camp *In its* Aero-Astrodyn. Res. Rev. No. 5 15 Oct. 1966 p 119–127 refs (See N67-20261 09-34)

The theoretical response of inertial-type anemometers is presented. The determination of response parameters using theory and wind tunnel data is explained and examples given. A comparison of simultaneous anemometer measurements in a real wind environment is made from which inferences are drawn regarding the validity of response parameters determined in a wind tunnel. Finally, the ground (surface to 150 m) wind measurement program being conducted is discussed, and some practical problems in measuring ground winds are outlined. Author

N67-20292# European Space Research Organization, Paris (France).
GENERAL INTRODUCTION TO INSTRUMENTATION PROBLEMS [INTRODUCTION GENERALE AUX PROBLEMES D'INSTRUMENTATION]
Pierre Blassel (European Space Technol. Center, Delft, Netherlands) Oct. 1966 18 p In FRENCH; ENGLISH Summary Presented at the ESRO Summer School, Oxford, 13 Aug. 1964
(ESRO-TM-41) CFSTI: HC $3.00/MF $0.65

Introduced are a series of eight lectures dealing with various problems of instrumentation in space research. It gives an exposition of the characteristics of telemetry, localization and synchronization, when used in the case of scientific satellites. Author (ESRO)

N67-20319# Gt. Brit. Ministry of Aviation, London.
RECONNAISSANCE TECHNOLOGY. PART I: RECONNAISSANCE FACILITIES IN CLEAR WEATHER [AUFKLAERUNGSTECHNIK. TEIL I: AUFKLAERUNGS-MITTEL BEI SICHTWETTER]
H. Gaertner Dec. 1966 27 p refs Transl. into ENGLISH from Jahr. Wehrtech. (Germany), Series 1, 1966 p 42–55
(TIL/T-5690) CFSTI: HC $3.00/MF $0.65

The ranges of various technical aids and their resolving power, the penetration of haze, effect of rain, passive and active techniques, infrared and line-scan systems are discussed, and the qualities of optical and photographic media used with the techniques. Author

N67-20346# Utah Univ., Salt Lake City. Upper Air Research Lab.
ROCKET INSTRUMENTATION FOR AURORAL MEASUREMENTS–NIROS AD 7.618D AND AD 7.619D
David A. Burt, Karl G. Seltaas, and Obed C. Haycock Oct. 1966 122 p refs
(Contract AF 19(628)-4995)
(AFCRL-66-738; SR-6; UU-66-11; AD-642729) CFSTI: HC $3.00/MF $0.65

The report details instrumentation developed for use in two Nike Iriquois (Niros) rockets AE 7.618D and AE 7.619D designed for auroral measurements and flown in 1965 at Fort Wainwright, Alaska, by Air Force Cambridge Research Laboratories. The two rockets were identical and carried instruments designed to measure the following: electron energy spectrum from 2.5 to 100 kev; energy deposition (electrons E > 8 kev and protons E > 100 kev); auroral light, 3914 A; auroral light wideband (4000 - 1200 A); electron density; Bremsstrahlung X rays (1 - 8 A); electron temperature; electron energy spectrum from 25 ev to 5 kev. Author (TAB)

N67-20363# Army Aeromedical Research Unit, Fort Rucker, Ala.
A RAPID TIMING SEQUENCER FOR TOXIC GAS SAMPLING
G. L. Hody and H. W. Huffman Nov. 1966 19 p refs
(USAARU-67-4; AD-644305) CFSTI: HC $3.00/MF $0.65

As part of a study of toxic hazards it is necessary to obtain samples of gases given off by rapid fire weapons and fast burning rocket motors. A solid state instrument was designed which can program solenoid valves for this purpose. The configuration chosen provides three individually adjustable interval timers. Each can be delayed from 25 to 5,000 milliseconds after firing of weapons, and can remain on for 30 to 4,000 milliseconds. The very short sampling times which are available enable acquisition of gas samples at pressures considerably below ambient, if this is desired to protect analytical instruments or to minimize chemical interactions in the sample. By adjustment of R-C time constants the timer range can be extended or reduced further to provide a versatile tool for future timing applications. Circuit details and performance data are presented. Author (TAB)

N67-20365# Kernforschungsanlage, Juelich (West Germany). Zentralabteilung Strahlenschutz.

AN AUTOMATIC SURFACE EVAPORATOR FOR DIRECT VAPORIZATION OF WATER SAMPLES IN A MEASURING CUP [EIN AUTOMATISCHER OBERFLAECHENVERDAMPFER ZUR DIREKTEINDAMPFUNG VON WASSERPROBEN IN MESSCHALEN]

R. Tzschaschel Apr. 1966 44 p refs In GERMAN (JUL-375-ST) CFSTI: HC $3.00/MF $0.65

Design and performance of an automatic water evaporator is described that utilizes the reflection from the liquid surface for optical regulation of the supply. A focusing lens concentrates the light beam of a small tubular lamp on the water's surface and another lens projects this intermediate image onto a photoresistor that displays the picture sidewise with receding water level and agitates an electromagnetic supply valve. This system works well with soft water but presents problems when hard or polluted water is used. In the latter case, surface accumulations of soot, sedimentation particles, or calcium prevent accurate light reflection and require chemical or mechanical pretreatment of the liquid before the evaporation process starts. Transl. by G.G.

15 MACHINE ELEMENTS AND PROCESSES

Includes bearings, seals, pumps, and other mechanical equipment; lubrication, friction, and wear; manufacturing processes and quality control, and reliability; drafting; and materials fabrication, handling, and inspection.

N67-19367# Israel Program for Scientific Translations, Ltd., Jerusalem.

MAKING PACKETS OF ELECTRICAL STEEL BY BONDING

L. M. Andrezen, G. E. Barantseva, K. K. D'yachenko, and Z. A. Kurdyukova *In its* Elec. Instrumentation in High-Energy Phys., Collection of Papers No. 1 1966 p 56–59 refs (See N67-19361 09-23) CFSTI: HC $3.00/MF $0.65

The development of several bonding materials is reviewed and the requirements for the materials are mentioned. After studying the physical and chemical properties of some resins, it was decided that the most suitable was the ED-6 epoxy resin. After testing amines, acid anhydrides, and amides, it was concluded that dicyandiamide made the best hardener. It was pointed out that it is less toxic and that it forms a bonding compound lasting 5 to 6 months. Quartz dust was mixed into the bonding compound to coat sheets of electrical steel; the viscosity was chosen for good spreadability on the surface of a sheet using rollers, giving a uniformly thick film without running. To obtain bonding films on a backing, a compound of lower viscosity was chosen. The manufacturing process, test results, mechanical strength, and purity are considered. L.E.W.

N67-19495 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

DETERMINATION OF AXIAL CONSUMPTION OF FLUID DURING ROTATION OF SHAFT

A. I. Belousov *In its* Aviation Eng., Vol. 7, No. 3 28 Sep. 1966 p 115–119 refs (See N67-19481 09-34) CFSTI: HC $3.00

Lubricant consumption along the axis of a working bearing under turbulent conditions of fluid flow is considered, taking into account the bearing shaft. There is a linear dependence of the square of the fluid consumption on pressure drop as the shaft rotates, and the additional resistance caused by rotation of shaft depends upon the geometry of the bearing slot. It is also noted that pressure drop is related to growth of peripheral velocity for a given slot. M.W.R.

N67-19538# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

INVESTIGATION OF VIBRATION STABILITY OF BEARINGS WITH GAS LUBRICANT

M. D. Shisheyev and G. A. Pospelov 31 Aug. 1966 20 p refs Transl. into ENGLISH from tr. Kazansk. Aviats. Inst. (Kazan), no. 66, 1961 p 97–109 (FTD-MT-64-298; TT-67-60344; AD-644560) CFSTI: HC $3.00/MF $0.65

A theoretical and experimental study was made of conditions of vibrationless operation of aerodynamic bearings in order to calculate methods of stabilization of the bearings. TAB

N67-19549# Boeing Scientific Research Labs., Seattle, Wash. Mathematics Research Lab.

ON THE DETERMINATION OF A SAFE LIFE FOR CLASSES OF DISTRIBUTION CLASSIFIED BY FAILURE RATE

Sam C. Saunders Jun. 1966 30 p refs *Its* Mathematical Note No. 469 (D1-82-0540; AD-640136) CFSTI: HC $3.00/MF $0.65

Using a lower tolerance bound as the derated life provides a guaranteed service period with the confidence level as a measure of safety in situations where mass production is contemplated. However, when only a limited number of items are to be produced, the probability of no failures among the fleet of specified size provides a better measure of assurance. Assuming that the life distribution is one of a specified set of subclasses of those distributions which have increasing failure rates we find those derating functions which can be used to provide lower tolerance bounds of given confidence or a safe service life with specified fleet assurance. A method of finding such derating functions is exhibited and the calculation of a lower bound for the probability of no failure in the fleet is carried out when such derating functions are used. The confidence in the tolerance bound and the assurance of no fleet failure are compared when using bounds obtained from these derating functions. Author (TAB)

N67-19591*# Oak Ridge National Lab., Tenn. Metals and Ceramics Div.

NONDESTRUCTIVE TESTING OF SMALL-DIAMETER REFRACTORY ALLOY TUBING

K. V. Cook and R. W. Mc Clung *In* AEC AEC–NASA Liquid Metals Inform. Meeting 23 Apr. 1965 p 79–97 refs (See N67-19581 09-17) CFSTI: HC $3.00/MF $0.65

A discussion is given of nondestructive methods used at ORNL to detect flaws and to measure dimensions of refractory metal tubes. The methods include ultrasonics, eddy currents, penetrants, radiography, and air gaging. The principles, equipment used, and applications of each method are discussed. NSA

N67-19608*# Westinghouse Electric Corp., Lima, Ohio. Aerospace Electrical Div.

EFFECTS OF ALKALI-METALS ON CERAMIC-TO-METAL SEAL SYSTEMS

P. E. Kueser *In* AEC AEC–NASA Liquid Metals Inform. Meeting 23 Apr. 1965 p 344–358 (See N67-19581 09-17) CFSTI: HC $3.00/MF $0.65

Ceramic and alkali metallic materials, and joining methods were investigated for small ceramic-to-metal seals. The metals chosen for their mechanical compatibility with ceramics and their corrosion resistance were Nb–1%Zr, Nb D-43 alloy, and tantalum T-111 alloy. The ceramic materials were selected on considerations of low impurities and a calculated thermodynamic stability in relation to the alkali metal. Metalizing-braze technique and the use of an active metal braze technique were chosen for the ceramic-to-metal joining. All samples were tested in Nb–1%Zr capsules in a vacuum purge glove box, and the results are tabulated. It was concluded that (1) the materials with more than 0.05% silica have poor potassium corrosion resistance at 1600°F. (2) The

metalized and brazed seals used do not appear satisfactory because of brittleness and low strength. (3) Active metal brazes are promising for the hermetic joining of the niobium alloys to ceramic bodies. N.E.N.

N67-19616# Denver Univ., Colo.
CENTER FOR HIGH-ENERGY-RATE FORMING
Arthur A. Ezra 1 Apr. 1966 3 p refs Prepared jointly with Martin Co.
(Contract DA-19-006-AMC-266(X))
(CR-65-77, Issue No. 3; AMRA-CR-66-05/3; AD-635572) CFSTI: HC $3.00/MF $0.65

The report includes: (1) Information Retrieval System: Work was begun on adapting an existing computer program at the University of Denver for storage and retrieval of information in high energy rate forming. (2) Shock Hardening or Strengthening of Metals; Investigations began on the use of a mouse-trap type of plane wave generator to provide known dynamic pressures. Velocity measurement techniques are being developed. Techniques are being developed for the preparation of specimens of shock loaded metals for electron microscope examinations. (3) Strain Rate Effects: Progress has been made in developing the optical light lever and streak camera techniques for measuring free surface displacements as a function of time. Strain rate of the order of 100 inches per inch per sec. were observed. (4) Computer Program for Predicting Process Parameters: The differential equations of motion for the large dynamic plastic deformation of a metal blank were programmed for solution on an IBM 1620 computer. Large deflection analysis was used, and implicit integration is being used in the programming to speed up computations. (5) Theoretical Determination of Formability Limits: The minimum blank width to diameter ratio required to prevent uneven pull was investigated theoretically. TAB

N67-19656*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
FABRICATION OF BERYLLIUM. VOLUME IV: SURFACE TREATMENTS FOR BERYLLIUM ALLOYS
R. F. Williams and S. E. Ingels Jul. 1966 24 p Prepared in part by Lockheed Missiles and Space Co.
(Contract NAS8-11798)
(NASA-TM-X-53453) CFSTI: HC $3.00/MF $0.65 CSCL 13H

This report documents the surface treatment techniques developed for use in the fabrication of beryllium aerospace vehicle structures. Proven techniques for the removal of surface contaminants resulting from in-process shop handling, and specific pre-cleaning and activation procedures for the preparation of the surface for subsequent operations such as plating and brazing, are reported. Author

N67-19657*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
THE FABRICATION OF BERYLLIUM. VOLUME III: METAL REMOVAL TECHNIQUES
R. F. Williams and S. E. Ingels Aug. 1966 144 p Prepared in part by Lockheed Missles and Space Co.
(Contract NAS8-11798)
(NASA-TM-X-53453) CFSTI: HC $3.00/MF $0.65 CSCL 13H

This report documents the metal removal techniques developed for the fabrication of beryllium aerospace vehicle structures. Proven production techniques for the drilling, routing, and abrasive wheel cutting of both sheet and plate gauges of material are presented. Established techniques for the precision machining of hot-pressed block and extruded rod are reviewed. Chemical milling solution strengths and metal removal rates are investigated; and the optimum Electrical Discharge Machining (EDM) power and frequency settings, and electrode materials, are correlated with the resulting metal removal rates, surface finishes and elapsed machine times. Metallographic and microphotographic techniques were used for comparison and failure analyses. Author

N67-19658*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
THE FABRICATION OF BERYLLIUM ALLOYS VOLUME II: FORMING TECHNIQUES FOR BERYLLIUM ALLOYS
R. F. Williams and S. E. Ingels Jul. 1966 101 p Prepared in part by Lockheed Missiles and Space Co.
(Contract NAS8-11798)
(NASA-TM-X-53453) CFSTI: HC $3.00/MF $0.65 CSCL 13H

This report documents the forming techniques investigated and developed for the fabrication of beryllium aerospace vehicle structures. Time-temperature relationships are established for the forming of straight bends, compound curved channels, and hemispherical segments. The flow of the material is determined, and the resulting dimensional changes are measured. The feasibility of the extreme forming of cross-rolled beryllium sheet material is demonstrated. R.U.

N67-19670# Linden Labs., Inc., State College, Pa.
MACHINING HIGH PURITY ALUMINA Quarterly Report, 31 Mar.–30 Jun. 1966
30 Jul. 1966 12 p refs
(Contract DA-36-039-AMC-03634(E))
(QR-8; AD-640695) CFSTI: HC $3.00/MF $0.65

The results of measurements of the properties of the 96% alumina bodies indicate that it is possible to fluorinate, machine and reconstitute a body of this composition and retain useful mechanical and dielectric properties. Author (TAB)

N67-19720# Massachusetts Inst. of Tech., Cambridge. Instrumentation Lab.
BALL MOTION IN ANGULAR CONTACT BEARINGS
Edward P. Kingsbury Oct. 1966 23 p refs
(Contract AF 33(615)-2243)
(E-2036; AD-643262) CFSTI: HC $3.00/MF $0.65

The nature of the frictional forces and moments applied to an angular contact bearing ball is examined in terms of slip, pivoting, spin and precession. Experimental methods for determining these quantities are given, together with results which indicate that the ball is ratainer-controlled for pivoting, and race-controlled for slip. Author (TAB)

N67-19805# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
THE OPERATION OF PUMPS AND AIR-BLOWING MACHINES AT LOWER FEEDING CONDITIONS
V. I. Polikovskiy and A. A. Levin 29 Aug. 1966 13 p refs Transl. into ENGLISH from Teploenerg. (Moscow), no. 10, 1965 p 71–74
(FTD-HT-66-124; TT-67-60353; AD-644640) CFSTI: HC $3.00/MF $0.65

In this report the authors make an effort to solve the problem of calculation at lower feeding conditions, on the basis of an actual picture of phenomena. To bring this solution to an end, unconditionally greater experimental investigations are needed to be carried out. It should be underlined, that the solution of this problem will allow a rational approach to the optimization of a series of geometrical parameters of the working sheels, determinable at present time on the basis of still unclear, purely experimental recommendations. TAB

N67-19815# Springfield Armory, Mass.
MODERN, EXTREME PRESSURE-TYPE, WATER-BASE, METAL-WORKING LUBRICANTS
M. S. Spivak 15 Apr. 1966 60 p refs
(SA-TR16-1062; AD-643157) CFSTI: HC $3.00/MF $0.65

Preliminary experiments were conducted to establish parameters for the development of a test or tests so that performance characteristics of metal-working lubricants could be evaluated.

Selected proprietary cutting-fluids were compared for performance in the Falex and in the Shell four-ball machines. The water and volatile content of each cutting-fluid concentrate was determined. Infrared spectra were obtained and data interpreted for each of the dehydrated, devolatilized concentrates. The presence of sulfur and metallic constituents in the concentrates was established. A modified Falex test procedure is outlined. A number of infrared spectra of typical compounds, used in the cutting-fluid formulations, are presented. Results of testing and comparisons indicate the complexity of the problem and the need for development of a workable and reproducible performance evaluation procedure. Author (TAB)

N67-19926* Fansteel Metallurgical Corp., Compton, Calif. Airtek Div.
PART NUMBER 4425008-901 "BOTTLE, GAS STORAGE, GAS BEARING SUPPLY" Final Report
[1966] 7 p
(Contract NAS8-11751)
(NASA-CR-82964) CFSTI: HC $3.00 CSCL 13H

Results are summarized from a study to design, fabricate, and test gaseous nitrogen storage bottles. It is reported that the manufactured vessels met and exceeded the physical and functional requirements of the qualification test program. At the conclusion of the qualification program three test specimens were pressurized to rupture. The average burst pressure of the three tanks was 8758.33 psig. An evaluation of the tensile test results has shown an average ultimate tensile strength of 174,041 psi. A.G.O.

N67-19957*# Mississippi State Univ., State College. Dept. of Electrical Engineering.
A STUDY OF INTENSE MAGNETIC FIELDS FOR HIGH ENERGY FORMING AND STRUCTURAL ASSEMBLY Interim Report
D. D. Wier, B. J. Ball, L. J. Hill, and G. S. Hyde [1966] 20 p refs
(Contract NAS8-20399)
(NASA-CR-82942) CFSTI: HC $3.00/MF $0.65 CSCL 13H

A study was conducted to determine the maximum force on a static sheet of aluminum subjected to the magnetic field of a hammer coil. Consideration was given to forces produced on four thicknesses of six aluminum alloys. The alloys and some of their characteristics are listed. Two methods of determining the force exerted on the aluminum sheet are suggested. One method requires a determination of the magnitude of the currents induced in the aluminum as a function of the current in the coil. The interaction of the fields produced by these two currents will be used to determine the force exerted on the sheet. The other method is to determine the self and mutual inductances of the coil and the aluminum sheet. From a system of equations having these inductances as coefficients, an equation for the force exerted as a function of current will be developed. It is not known which of the two methods will give better or more accurate results as no equipment is available for checking experimentally the theoretical results obtained. R.N.A.

N67-19965* Boeing Co., Seattle, Wash. Aerospace Group.
INERT GAS WELDMENT EFFECTS STUDY Final Report, 27 Jan–27 Jun. 1966
W. Evan Strobelt 27 Jun. 1966 30 p
(Contract NAS8-20168)
(NASA-CR-82970; D2-23647-6) CFSTI: $3.00 CSCL 13H

An experimental study to quantitatively relate gas contamination in the shielding medium to the magnitude, frequency, and level of porosity in 2219-T87 aluminum weldments is summarized. A determination was made of the ranges for which a relationship exists between contaminants (O_2, N_2, H_2, and H_2O) in the arc shielding medium and weldment defects. Also determined were the shielding gas contamination effects on porosity, mechanical properties, and the metallurgical characteristics of the weldments. The tungsten-arc inert-gas shielding process was used while welding in the horizontal position. The experimental equipment included a 400-ampere power supply, an atmosphere control chamber, and a gas measurement control system. A statistical approach was used to guide the study, and consisted essentially of a response surface design to provide the data needed to fit mathematical models for each measure of weld quality. A uniform weld schedule designed to simulate production conditions was established for the preparation of all weldments, with major variables consisting of the gas contaminants, oxygen, nitrogen, hydrogen, and water vapor. C.T.C.

N67-19969 Saunders-Roe, Ltd. (Gt. Brit.)
PIN FRETTING FATIGUE IN ALUMINUM ALLOY LUGS, PART 4
A. W. Andrews, E. Heber, and F. A. Kerry Apr. 1966 54 p refs
(Contracts KS/6/EXP/3113/CB.38b; KS/1/0202/CB.43(a)2)
(S&T-Memo-11/65)

Tests were carried out to determine the effects of various jointing compounds on the fretting fatigue characteristics of aluminium alloy lugs. Work was carried out using D.T.D.363, L.65, and D.T.D.5054 lugs and Rotol ASP, D.T.D.5530, Duralac 3389, Duralac 6236, and British Timken Frin jointing compounds. Tests were carried out at three levels of mean stress, each level with a range of dynamic stresses. Tests were also carried out on compounds, greases, and special treatments which had not been tested previously. The best results were obtained with lugs in which the holes had been work hardened by pressing through a 1.5% oversize hardened steel ball (ballized). Author

N67-19992*# National Research Corp., Cambridge, Mass.
SURFACE CLEANING TECHNIQUES IN ULTRAHIGH VACUUM
F. J. Brock [1966] 58 p refs
(Contract NAS1-2691)
(NASA-CR-66273) CFSTI: HC $3.00/MF $0.65 CSCL 13H

The results of a study to experimentally investigate in-vacuum methods for obtaining clean surfaces and for measuring surface cleanliness are presented. Ion bombardment and abrasion with a rotating wire brush were used for obtaining clean surfaces and measurement of the work function was used to indicate surface cleanliness. Author

N67-19993* Arinc Research Corp., Huntsville, Ala.
RELIABILITY DEMONSTRATION USING OVERSTRESS TESTING Special Technical Report No. 21
Donald A. Authement, Charles E. Foshee, Fredrick C. Herzner, and Charles M. Orr 30 Jul. 1965 66 p refs
(Contract NAS8-11087)
(NASA-CR-82924; Publ.-294-24-24-505) CFSTI: $3.00 CSCL 14D

A new approach to accelerated testing is presented. The approach consists of testing several components to failure in an overstress condition and extrapolating the failure data obtained to the usage condition. While the proposed method is not an ultimate solution to the problem of reliability demonstration with few samples, it does represent an initial step in the direction of solving overstress testing problems. Its principal advantage is the time it saves. An analysis of test data shows reductions in test time by factors of from 3 to 2000 compared to that which would be required by testing at operational stress levels. In addition to the proposed test approach, the results of a literature search, an annotated bibliography, and some experimental test results are reported. Author

N67-20283 Societe Belge pour l'Industrie Nucleaire, Brussels (Belgium).
STUDY OF THE USE OF RADIOISOTOPES FOR LABELING REFRACTORY MATERIAL USED IN FOUNDRY [ETUDE SUR L'UTILISATION DES RADIOISOTOPES POUR LE MARQUAGE DES MATERIAUX REFRACTAIRES UTILISES EN FONDERIE]
Cl. Descamps, E. Delporte, R. Berger, P. Nicolaides, and L. Jassogne (Usines Emile Henricot) Brussels, EURATOM, Nov. 1966 120 p refs
(Contract EURATOM-011-62-12-IRAB)
(EUR-3169.f)

The aim of our work was concentrated on the development of practical methods to be used by the metalcasters for control and detection of exogenic inclusions in castings without demolishing them, in opposition with the other methods known. Two labeling methods have been used, both utilizing zirconium 95 as tracer. For the casting accessories in moulding sand a "dry" method has been used, consisting of mixing mechanically, with these sands, zircon previously irradiated in a reactor. For casting accessories in the form of well determined refractory pieces, a "wet" method has been used to introduce the tracer into those elements. The tracer, in the form of a zirconium nitrate solution, is sprayed on the refractory. The pieces undergo hereafter a thermal treatment transforming the zirconium nitrate into oxide. Different metallic pieces have been cast by means of those labeled accessories. The inclusions have been detected without difficulty by passing a scintillator over the pieces. The two methods proved very practical in use and the sensitivity of detection permits an easy locating of inclusions from about 15 mg, inserted in 3 mm thick steel.
Author

N67-20316# Gt. Brit. Ministry of Aviation, London. Technical Information and Library Services.
THE BURNING-IN OF BRIGHT PLATINUM ON GLASS [UEBER DAS EINBRENNEN VON GLANZPLATIN AUF GLAS]
G. Jeromin Dec. 1966 8 p refs Transl. into ENGLISH from German
(TIL/T-5714) CFSTI: HC$3.00/MF$0.65

Taking the example of the preparation of platinum coatings on AR glass by burning-in bright platinum, the influence of method of cleaning the glass, rates of heating and cooling, burning-in temperature and air-flow were investigated and optimum conditions determined. On this basis burning-in instructions were compiled for producing electrodes with a high chemical resistance. The catalytic action of the bright platinum in hydrogenation reactions is being investigated.
Author

N67-20328# European Atomic Energy Community, Brussels (Belgium).
AN IMPROVED METHOD OF QUANTITATIVE AUTORADIOGRAPHY FOR INDUSTRIAL PURPOSES
L. Matteoli and P. Logi (Inst. di Ric. Breda) Dec. 1966 66 p refs Prepared by Inst. di Ric. Breda
(EURATOM-008-62-10-IRAI)
(EUR-3173.e) CFSTI: HC$3.00/MF$0.65

A method has been set up that requires the exposure at the same time and with the same photographic emulsion of standards of radioactivity and of the sample under examination, tagged with the radioactive tracer. On the autoradiographs obtained, the blackening produced by the beta radiation exposure is measured by a microphotometer. By comparison of the photographic densities of the standard and the sample autoradiographs, a correlation is calculated between photographic density and radioactivity of the tracer, and between photographic density and the concentration of the tagged constituent in the sample. Series of radioactivity standards were prepared for ten beta-emitting radioisotopes and their relative photographic efficiency determined. Working conditions for reproducible exposures and developments were also determined and several photographic emulsions were tested. A method to make thin sections of metals and minerals specimens was developed. Quantitative autoradiography was applied in five studies, that illustrate possible applications. These studies refer to the examination of components liquation in alloys; the tagging of a mineral; and to the absorption on steel surface of a corrosion inhibitor.
Author

N67-20333 Gt. Brit. Ministry of Aviation, London.
THE DRAG OF A LARGE AND SMALL PNEUMATIC TYRE TRAVELLING THROUGH WATER, SLUSH AND SNOW
R. W. Sugg Oct. 1966 31 p ref
(S&T-Memo-9/66) CFSTI: HC$3.00

Tests were made with a 35×10–17 aircraft tire using the heavy load test and results were compared with those from a 13 in. diameter, 3 in. wide tire in trials of a recently developed device, a slush drag meter, which was designed to measure the water equivalent depth of runway contamination. Trials were conducted on natural snow, on water and ground ice with the small tire and slush drag meter, and with the aircraft tire. Within the speed range of the tests (up to 90 ft/sec.) it was found that drag varied linearly with velocity squared in water and ground ice with both tires, and with the small tire in snow. With the small tire, drag per inch increased with depth but was constant with the large tire.
Author

N67-20352# Gt. Brit. Ministry of Aviation, London. Technical Information and Library Services.
THE ACOUSTIC BEHAVIOUR OF CARBON BRUSHES IN SMALL MACHINES [UEBER DAS AKUTISCHE VERHALTEN DER KOHLEBUERSTEN BEI KLEINMACHINEN]
W. Volkmann Sep. 1966 5 p refs Transl. into ENGLISH from Elektrotech. Z. (Berlin), v. 18, no. 3, 1966 p 82–83
(TIL/T-5686) CFSTI: HC$3.00/MF$0.65

Normally the brush noises of small machines are lost against the background of other noises, e.g. bearings, fan. But irregular, high noise level chatter and whistling may occur. The former is due to untrue commutators. Two causes of whistling are explained.
Author

16 MASERS

Includes applications of masers and lasers. For basic research see: 26 Physics, Solid State.

N67-19461*# Arkansas Univ., Little Rock.
INVESTIGATION OF LASER PROPERTIES RELEVANT TO THE MEASUREMENT OF DIFFERENT PHYSICAL PARAMETERS Status Report, Period Ending 31 Dec. 1966
31 Dec. 1966 75 p refs
(Grant NsG-713)
(NASA-CR-82828) CFSTI: HC$3.00/MF$0.65 CSCL 20E

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N67-19462*# Arkansas Univ., Little Rock.
HOLOGRAPHY: LASER INTERFEROGRAMS
R. M. Jones *In its* Invest. of Laser Properties Relevant to the Meas. of Different Phys. Parameters 31 Dec. 1966 p 1–4 (See N67-19461 09-16) CFSTI: HC$3.00/MF$0.65

The effect of a schlieren field on the holographic reconstruction of a grating or of a recorded interference pattern was investigated to demonstrate the production of a zero or low-order interferogram from a higher order interferogram. Two collimated laser beams were brought together at an angle on a photographic plate, which recorded the interference lines formed. The plate was a high-order interferogram of the two beams. With the plate back in place in the beams, the same pattern was incident on the plate. The two interferograms in exact alignment produced a single dark or light band which was a zero-order interferogram. There was more than one fringe when the frequency of the lines was altered by changing the angle of the beams, or when the recorded interference pattern was tilted at a slight angle to that produced by the beams. The fringes were visible on the plate and as a projected pattern behind the plate. The angle of the two beams gave a line frequency of about 50 lines/mm. When a schlieren field was placed in either beam it became clearly visible. R.N.A.

N67-19464*# Arkansas Univ., Little Rock.
PULSED LASER HOLOGRAMS
Robert H. Gibbons *In its* Invest. of Laser Properties Relevant to the Meas. of Different Phys. Parameters 31 Dec. 1966 p 9–13 (See N67-19461 09-16) CFSTI: HC$3.00/MF$0.65

Work was conducted on improving pulsed laser holograms to obtain high quality holograms that can be reconstructed with gas lasers. The systems studied were set up using focusing optics to collimate and enlarge the beam coming from the ruby laser. Although first order reconstructions were obtained, the images were not distinguishable because the beam ionized the air at the point of focus and disrupted its coherence. A vacuum chamber was built to permit the beam to be focused in vacuo during collimation. A pinhole was used to spatially filter the beam during collimation. The vacuum chamber eliminated the problems of focusing the laser beam in air and successful holograms were obtained on both glass plate and aerial films. The reconstructed images could be distinguished, but the hologram image made on glass plate film was more distinct because of its higher resolving power. To obtain high quality ruby laser holograms, it is shown that consideration must be given to the laser coherence length and to the elimination of the laser's longitudinal and transverse modes. The best pinhole material is stainless steel foil 0.010-in thick. Pinholes 0.0005-in in diameter were obtained but they were destroyed with as few as ten laser firings. R.N.A.

N67-19465*# Arkansas Univ., Little Rock.
SCHLIEREN HOLOGRAPHY-RAY TRACING
Robert L. Bond *In its* Invest. of Laser Properties Relevant to the Meas. of Different Phys. Parameters 1 Dec. 1966 p 14–18 (See N67-19461 09-16) CFSTI: HC$3.00/MF$0.65

An effort is being made to exploit the hologram's ability to record all information contained in the rays that have passed through a schlieren field. Work to date has been directed toward determining the feasibility of using a hologram to study the angles through which rays are deviated by an object in the information beam. Simple static objects with well known or readily determined properties were used. A continuous laser was used; however, the study of constructing suitable holograms with a giant pulsed laser was made simultaneously. Hologram construction and reconstruction methods were studied together to ascertain the optimum configurations of the optical systems and to minimize error in the readout of the deviated rays and their correlation to the ray deviation by the original object. Parallel carrier and information beams were used to minimize readout difficulties. Aberrations in the optics needed to produce the large diameter well collimated reference and information beams have continued to produce high error in the reconstructions. A multistep process was developed to eliminate the precise alignment needed with image holography and to correct the reconstructed image inversion. R.N.A.

N67-19709# Ballistic Research Labs., Aberdeen Proving Ground, Md.
DESIGN OF AN AIRBORNE LASER BEAM PROFILE MONITOR
Morgan T. Reedy Aug. 1966 18 p ref
(BRL-TN-1625; AD-642163) CFSTI: HC$3.00/MF$0.65

A system for sensing and recording the profiles of a CW laser beam on a propagation path of approximately 30 degree elevation and 3 miles slant range was developed. The parameters of interest are beam dispersion and energy density fluctuations due to turbulence effects. Author (TAB)

N67-19728# Columbia Univ., New York. Plasma Lab.
CONTROL OF METASTABLES BY OPTICAL METHODS AND ITS APPLICATION TO GASEOUS LASERS Final Report, 1 Jun. 1963–1 Oct. 1966
Thomas C. Marshall and Bertram Pariser 1 Oct. 1966 33 p refs
(Contract Nonr-266(93); Proj. Defender)
(Rept.-26; AD-642710) CFSTI: HC$3.00/MF$0.65

Experimental work on the gaseous electronics of the He-Ne laser is reviewed. Application of optical pumping techniques for the control of He and Ne metastable populations are described and applied to the gas laser. Author (TAB)

N67-19979# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
LASER LIGHT ADVANCES IN AVIATION
Yen You Chin 23 Sep. 1966 16 p Transl. into ENGLISH from Hang K'ung Chih Shih, no. 7, 1964 p 7–12
(FTD-TT-65-361; AD-643959) CFSTI: HC$3.00/MF$0.65

The article examines laser light advances in the field of aviation and its applications in communications, searching, tracking and interception. TAB

N67-20005# Union Carbide Corp., East Chicago, Ind. Electronics Div.
PRODUCTION ENGINEERING MEASURE FOR RUBY LASER RODS Quarterly Progress Report, 1 Apr.–30 Jun. 1966
M. K. Towne, O. H. Nestor, and L. R. Rothrock 30 Jun. 1966 34 p
(Contract DA-36-039-AMC-06168(E))
(QPR-4; AD-643859) CFSTI: HC$3.00/MF$0.65

Additional multi-variable runs have been completed in the process engineering studies. These runs have established optimum values for process parameters for ruby growth in a furnace chamber of specific size. It was shown that, contrary to original expectation, the pulsed powder feed system is preferred over continuous feed. A description of the system and procedures used in active laser tests is presented. The results of active and passive tests on all engineering samples are summarized and discussed. Author (TAB)

N67-20154# Stanford Univ., Calif. Linear Accelerator Center.
SLAC ALIGNMENT SYSTEM
W. B. Herrmannsfeldt Oct. 1966 17 p refs Presented at LSAL Linear Accelerator Conf., Los Alamos, N. Mex., 10–13 Oct. 1966
(Contract AT(04-3)-400)
(SLAC-PUB-222; CONF-661021-15) CFSTI: HC $3.00/MF $0.65

A review of the operating experiences with the laser alignment system of the two-mile linear accelerator is presented. It includes discussions of some of the special alignment techniques used prior to the initial start up of the accelerator. Author (NSA)

N67-20183# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
LASER
Ang-ju Chu 21 Nov. 1966 20 p Transl. into ENGLISH from Tien Tzu Chi Shu (Communist China), no. 3, 1964 p 24–28
(FTD-TT-65-1453; TT-67-60190; AD-643606) CFSTI: HC $3.00/MF $0.65

The similarities between light and electromagnetic waves are compared. The laser oscillator is described along with laser radiation. The use of the laser in space research, communication, medicine, photography, etc., is described. The ruby laser and a gaseous state laser are described. Author (TAB)

N67-20348# Massachusetts Inst. of Tech., Cambridge. Dept. of Electrical Engineering.
EFFECTS OF PRESSURE ON A SEMICONDUCTOR LASER RADIATION
Jose Ellis Ripper Filho (Ph.D. Thesis) 19 Sep. 1966 146 p refs
(Contracts Nonr-1841(51); DA-31-124-ARO(D)-92)
(TR-5; AD-642514) CFSTI: HC $3.00/MF $0.65

The results of the relativistic APW calculation of the band structure, momentum matrix elements and deformation potentials of the lead salts are used to calculate the effects of constant pressure on lasers made of these materials. Behavior of the frequency, polarization and relative gain of these lasers are calculated for several dopings, and injection levels, when isotropic and uniaxial pressures are applied. The effect of small dynamic pressure on semiconductor lasers is analyzed, resulting in a frequency modulation of the laser radiation. An experiment confirming this analysis was performed. A 2 Mc/s frequency modulation was introduced into a cw GaAs injection laser with an ultrasonic wave. This modulation was then detected with the use of a Fabry-Perot interferometer. A theoretical analysis of the limitations of the method of modulation demonstrated above was carried out with a regard to its device applications. Author (TAB)

N67-20379*# Sylvania Electric Products, Inc., Mountain View, Calif.
FREQUENCY STABILIZED GAS LASER Final Summary Engineering Report, 17 Jun. 1966–17 Feb. 1967
R. S. Reynolds, J. D. Foster, A. A. Kamiya, and A. E. Siegman 17 Feb. 1967 84 p refs
(Contract NAS8-20631)
(NASA-CR-82981) CFSTI: HC $3.00/MF $0.65 CSCL 20E

To provide long-term stabilization, a technique which allows a CO_2 laser, operating at a wavelength near 10.6 microns, to be stabilized with respect to a nonregenerative CO_2 amplifier was chosen. This technique is analyzed and shown to be capable of providing a frequency stability of about 1 part in 10^{10} using presently available 10-micron detectors. Factors affecting the absolute stability of the CO_2 amplifier frequency are discussed with the conclusion that the pressure variations within the amplifier tube may be the limiting factor for long-term frequency stability. A detailed design is presented for a CO_2 laser system capable of providing greater than 1/2 watt of 10.6 micron radiation, frequency stabilized to within 3 kHz. Techniques for ensuring single-frequency operation in the CO_2 laser without degradation in power output are also discussed. Author

17 MATERIALS, METALLIC

Includes cermets; corrosion; physical and mechanical properties of materials; metallurgy; and applications as structural materials. For basic research see: 06 Chemistry. For related information see also: 18 Materials, Nonmetallic; and 32 Structural Mechanics.

N67-19411# Toronto Univ. (Ontario).
MATERIALS SCIENCE AND STRUCTURES
In its Ann. Progr. Rept., 1966 Oct. 1966 p 62–72 (See N67-19403 09-34)

Materials science and structures research with respect to fatigue mechanisms is reported. More than 630 specimens were tested to establish Swanson's evidence of a bimodal endurance distribution at stress levels around the lower knee, on a proper statistical basis. Attempts were also made to establish correlation or identity between the statistically defined fatigue mechanisms and Wood's H and F ranges. Other projects were conducted to determine the parameters which possibly influence or cause activation of that fatigue mechanism which ultimately leads to specimen failure. One such study establishes the effect of grain size on the S–N curve in general and the bimodal endurance distribution in particular. Another examines the effect of humidity on the bimodal endurance distribution. A third investigates the influence of a cold worked surface layer on the fatigue behavior of pure copper in alternating tension-compression. Other topics considered are the buckling of photoelastic circular cylinders in axial compression, the effects of cutouts in photoelastic circular cylinders under axial compression, and propagation of spherical elastic-plastic waves in solids. S.P.

N67-19416*# Douglas Aircraft Co., Inc., Newport Beach, Calif. Astropower Lab.
STRESS CORROSION CRACKING OF TITANIUM ALLOYS AT AMBIENT TEMPERATURE IN AQUEOUS SOLUTIONS Quarterly Progress Report, Oct.–Dec. 1966
T. L. Mackay and C. B. Gilpin Jan. 1967 32 p refs
(Contract NAS7-488)
(NASA-CR-82796; SM-49105-Q2) CFSTI: HC $3.00/MF $0.65 CSCL 11F

Specimens of Ti–5Al–2.5Sn, Ti–6Al–4V, Ti–8Al–1Mo–1V and Ti–13V–11Cr–3Al were prepared for stress corrosion tests (single edge notch specimens), transmission electron microscopy, and electron microautoradiography. Stress corrosion tests in 3% sea water were initiated. K_c values for Ti–8Al–1Mo–1V in argon averaged 44.2 ksi$\sqrt{\text{in.}}$, whereas K_c values in sea water were between 18.5 and 28.0 ksi$\sqrt{\text{in.}}$ and in distilled water between 30.4 and 36.6. Electron microautoradiographic studies of the distribution of hydrogen in titanium alloys were initiated. Radioactive hydrogen (tritium) was introduced by cathodic charging and by gas adsorption at elevated temperature. Preliminary autoradiographs showed tritium introduced by cathodic charging to be distributed evenly throughout the lattice in the Ti–5Al–2.5Sn alloy. In the Ti–6Al–4V alloy no tritium was observed in the beta phase. At low charging current densities, tritium was evenly distributed in the alpha lattice, whereas at higher current densities tritium appeared to concentrate in alpha–beta boundaries and alpha–alpha boundaries. No tritium was observed in the beta alloy Ti–13V–11Cr–3Al. Author

N67-19571# Vermont Univ., Burlington.
THE EFFECTS OF HIGH UNIAXIAL COMPRESSIVE STRESS ON GLASS
J. O. Outwater and D. J. Gerry 10 Aug. 1966 19 p refs
(Contract Nonr-3219(01)(X))
(AD-640847) CFSTI: HC $3.00/MF $0.65

Necked Pyrex rods were used to obtain the values of uniaxial compression stress on glass. Stresses up to 647,000 psi were measured and some unusual phenomena were noted: Instead of splintering, the glass failed by giving a coherent mass and at the

same time set up tensile waves in the specimen. Light was emitted on failure. No creep was observed either under direct uniaxial stress of between 400,000 and 500,000 psi of 1 sec. duration or in the areas of stress concentration around a cylindrical hole drilled through the point of highest stress. The results of this work tend to substantiate a time dependent plastic flow theory. Author (TAB)

N67-19581*# Atomic Energy Commission, Washington, D. C. Div. of Technical Information.
AEC–NASA LIQUID METALS INFORMATION MEETING
23 Apr. 1965 429 p refs 5th Meeting held at Gatlinburg, Tenn. and at Oak Ridge Natl. Lab., 21–23 Apr. 1965
(NASA-CR-82838; CONF-650411) CFSTI: HC $3.00/MF $0.65 CSCL 11F

In the conference papers presented, emphasis is placed on solubility studies and impurity effects in alkali metals; corrosion by liquid sodium, NaK, and lithium; and corrosion by boiling alkali metals. For individual titles, see N67-19582 through N67-19611.

N67-19587*# Los Alamos Scientific Lab., N. Mex.
THE OXIDATION OF REFRACTORY METALS IN LIQUID SODIUM
James M. Williams *In* AEC AEC–NASA Liquid Metals Inform. Meeting 23 Apr. 1965 p 57–60 (See N67-19581 09-17) CFSTI: HC $3.00/MF $0.65

The oxidation characteristics of possible hot getters and of core container material are examined, as a basis for predicting the kinetics of hot trapped systems. To provide the necessary environmental conditions, a hot trap evaluation loop was constructed for the experiments on oxidation in cold trapped sodium. Materials studied as oxygen getters were Zr, Ta, Ta–10W, Nb, and 50Ti–50Zr. In the experimental approach to oxidation in hot trapped sodium, a hot trap of corrugated Zr foil was fabricated, and designed to be inserted into the hot trap evaluation loop. A correlation for Zr oxidation is postulated, based on data obtained in a 10 to 20 ppm range of oxygen concentration, which predicts oxidative weight gain as a function of time, temperature, and oxygen concentration. A tentative weight loss correlation is also presented for Ta and Ta–10W. The 50Ti–50Zr alloy appears to be a more efficient hot trap than Zr, but fabrication qualities are not as desirable. It is also concluded that the oxidation rates of Ta and Ta–10W can be kept below 0.1 mil/yr in Zr hot trapped Na. M.G.J.

N67-19588*# Oak Ridge National Lab., Tenn. Metals and Ceramics Div.
INTERACTIONS IN THE NIOBIUM–OXYGEN–POTASSIUM SYSTEM
A. P. Litman *In* AEC AEC–NASA Liquid Metals Inform. Meeting 23 Apr. 1965 p 61–62 (See N67-19581 09-17) CFSTI: HC $3.00/MF $0.65

To evaluate corrosion mechanisms in the Nb–O–K system, experiments were conducted in which the boundary conditions were temperatures of 200°, 600°, and 815°C; test times of 1 to 500 hours; and oxygen concentrations of 50 to 2600 ppm individually and collectively in the niobium and potassium. The results show: (1) Higher initial oxygen concentrations in niobium resulted in higher rates of oxygen transfer and more rapid production of surface scale. An initial concentration of approximately 1000 ppm was a prerequisite for subsurface corrosion formation. (2) Surface scales were observed when the initial oxygen in the potassium was 50 ppm. Higher oxygen concentrations in the potassium induced more rapid thickening of the surface products on the niobium. (3) Higher test temperatures produced thicker surfaces on the niobium and caused the subsurface phase to form more quickly. The mass transfer of oxygen and niobium progressed rapidly as the temperature was raised. (4) Maximum scale thickness was observed at 25 hours at elevated temperatures. M.G.J.

N67-19589*# Pratt and Whitney Aircraft, Middletown, Conn.
STUDIES CONCERNING THE CHEMICAL STATE OF CARBON, NITROGEN AND OXYGEN IN ALKALI METALS
K. J. Kelly, E. W. Hobart, and R. G. Bjork *In* AEC AEC–NASA Liquid Metals Inform. Meeting 23 Apr. 1965 p 64–73 refs (See N67-19581 09-17) CFSTI: HC $3.00/MF $0.65
(Contract AT(30-1)-2789)

In an effort to extend the physical and analytical chemistry of reactive elements in alkali metals, small quantities of elemental carbon and compounds of carbon with hydrogen, oxygen, and nitrogen were reacted with lithium and sodium to evaluate the stability of various chemical states. Tests with carbonate–lithium mixtures showed that acetylene was the major gas product evolved from mixtures heated at 600°C and above. Experiments on the chemical state of nitrogen indicate that complexes of nitrogen with carbon or oxygen are decomposed in 600°C lithium to yield nearly theoretical recoveries of ammonia upon hydrolysis. This implies that nitrogen in 600°C lithium is present predominantly as the nitride and is independent of carbon or oxygen impurities in the solvent. Preliminary data infer: (1) The sodium–carbon system is more complex than its lithium counterpart. (2) Methanides and acetylides apparently exist in significant quantities. (3) Nitrogen and oxygen may form important complexes with carbon. M.G.J.

N67-19593*# MSA Research Corp., Callery, Pa.
THE EFFECT OF SODIUM ON THE MECHANICAL PROPERTIES OF AUSTENITIC AND FERRITIC STEELS
R. C. Andrews *In* AEC AEC–NASA Liquid Metals Inform. Meeting 23 Apr. 1965 p 108–118 (See N67-19581 09-17) CFSTI: HC $3.00/MF $0.65

Results are presented on creep, rupture, and fatigue tests conducted on 316 stainless steel at 1200°F, and 2-1/4% chromium–1% molybdenum steel at 1100°F. Environments used are air; helium; and sodium with less than 30 ppm oxygen, with 300 ppm oxygen; and with a continuous carbon source. The effect of carbon and oxygen contaminants in the sodium on the corrosion–mechanical characteristics of the structural materials is assessed, based on the preliminary data. M.G.J.

N67-19596*# Battelle Memorial Inst., Columbus, Ohio.
REFRACTORY METALS IN LITHIUM AT ELEVATED TEMPERATURES
J. A. De Mastry and N. M. Griesenauer *In* AEC AEC-NASA Liquid Metals Inform. Meeting 23 Apr. 1965 p 130–136 Sponsored by AF (See N67-19581 09-17) CFSTI: HC $3.00/MF $0.65

Experimental details are given on tests conducted to determine the resistance of certain refractory metals to attack by liquid lithium in the 2500° to 3000°F temperature range. These materials included tungsten, W–15Mo, W–25Re, TZM, Ta–12W, and Nb–5Mo–5V–1Zr specimens which were loaded into a TZM corrosion capsule. Sufficient lithium to completely cover the specimens at temperature was loaded into each capsule at room temperature to minimize contamination. The capsules were welded, then heat treated in vacuum resistance furnaces for 100 or 1000 hours at 2500°, 2800°, or 3000°F. After furnace cooling the corrosion capsules were opened in a helium glove box and the contents examined. Among the results reported are: (1) The tungsten-base materials undergo moderate to severe surface dissolution when exposed to static lithium at 2800°F and above. (2) Outstanding resistance to attack by lithium at 3000°F for up to 1000 hours is shown by TZM. M.G.J.

N67-19598*# Oak Ridge National Lab., Tenn. Metals and Ceramics Div.
CORROSION OF ADVANCED REFRACTORY ALLOYS IN LITHIUM
C. E. Sessions *In* AEC AEC–NASA Liquid Metals Inform. Meeting 23 Apr. 1965 p 143–148 refs (See N67-19581 09-17) CFSTI: HC $3.00/MF $0.65

Static and thermal convection loop tests for evaluation of high temperature compatibility of lithium and refractory alloys are reported. Exposure to lithium was at either 500° or 1000°C for 100 hr, pretest oxygen levels were adjusted in the range 100 to 3000 ppm O, and selected specimens were vacuum heat treated at 1000° to 1600°C. The results are tabulated, and the corrosion behavior of Nb–1% Zr is discussed. Procedures are outlined for testing small loops in a stainless steel ball jar with a vacuum of 10^{-9}–10^{-9} torr to determine the compatibility of the alloys in flowing, nonisothermal lithium at elevated temperatures. The Nb–1% Zr loops were operated for a 3000 hour test with a maximum hot leg temperature of 1200°C and a temperature drop of approximately 120°C. One loop contained 58 Nb–1% Zr specimens interlocked continuously around the loop, and the second contained TZM inserts with six Nb–1% Zr inserts. Data on weight change profiles are graphed and discussed. N.E.N.

N67-19599*# General Electric Co., Cincinnati, Ohio. Space Power and Propulsion Section.

NEW COMPONENTS FOR REFRACTORY METAL–ALKALI METAL CORROSION TEST SYSTEMS

E. E. Hoffman and J. Holowach *In* AEC AEC–NASA Liquid Metals Inform. Meeting 23 Apr. 1965 p 149–214 refs (See N67-19581 09-17) CFSTI: HC $3.00/MF $0.65

Vacuum test chamber components, reflux capsule corrosion test components, and components of forced circulation, two-fluid corrosion test loop systems are discussed. The components were evaluated in connection with the potassium corrosion test loop program. Details are presented on the getter-ion pumps to produce high vacuum test chamber environments. Components for the reflux capsule corrosion test include those connected with test specimen preparation, accurate temperature measurement, reflux rate measurement, and boiling stability. Components for the forced convection loop described are: liquid metal pumps, flow control and isolation valves, resistance heaters, reflective insulation, vapor bubble nucleators, liquid metal boilers, turbine simulator, condenser and subcooler, and temperature and pressure measuring devices. N.E.N.

N67-19600*# Brookhaven National Lab., Upton, N. Y.

A SUMMARY OF THE HIGH TEMPERATURE ALKALI METAL CORROSION PROGRAM AT BROOKHAVEN NATIONAL LABORATORY

A. J. Romano, A. H. Fleitman, and C. J. Klamut *In* AEC AEC–NASA Liquid Metals Inform. Meeting 23 Apr. 1965 p 217–234 (See N67-19581 09-17) CFSTI: HC $3.00/MF $0.65

Research to evaluate refractory metals and alloys for containing liquid and boiling sodium in the temperature range 1000°–1315°C are summarized. Emphasis was placed on the evaluation of Nb–1Zr in capsules and loops, and the results are described and tabulated. Tests on Ta base alloys and other Nb base alloys are also described. N.E.N.

N67-19601*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

SUMMARY OF THE POTASSIUM–REFRACTORY METAL CORROSION CAPSULE PROGRAM AT NASA LEWIS RESEARCH CENTER

C. M. Scheuermann *In* AEC AEC–NASA Liquid Metals Inform. Meeting 23 Apr. 1965 p 235–236 (See N67-19581 09-17) CFSTI: HC $3.00/MF $0.65

A refractory metal corrosion capsule program, whose purpose is to test the corrosion resistance of potential niobium and tantalum tubing alloys to boiling potassium, is reviewed. The materials being studied and their nominal compositions are presented in tabular form. The tests which were conducted, using refluxing capsules made of the test alloy rod stock, machined to 1/2-in. diameter, 1-3/4 in. length, and 0.040-in. wall thickness, are briefly described. Preliminary results obtained from the tests are summarized for the following materials: B-33; SNb-291; Nb–1Zr; Ta–10W; X-110; D-14, B-66, Nb-752, AS-55, and C-129; FS-85; and T-111. L.E.W.

N67-19602*# Battelle Memorial Inst., Columbus, Ohio.

MASS TRANSFER OF TZM ALLOY BY POTASSIUM IN BOILING-REFLUXING CAPSULES

E. M. Simons and J. F. Lagedrost *In* AEC AEC–NASA Liquid Metals Inform. Meeting 23 Apr. 1965 p 237–271 refs Sponsored by AF Prepared for Aires. Mfg. Co. (See N67-19581 09-17) CFSTI: HC $3.00/MF $0.65

During the course of creep experiments in a potassium vapor environment to check the suitability of TZM alloy for the wheels and blades in a potassium-vapor turbine, a potential mass-transfer problem was uncovered. A series of TZM capsule experiments with boiling-refluxing potassium was performed to determine qualitatively how various system parameters influence the mass transfer. It was found that TZM mass transfer is aggravated by high oxygen contamination in the potassium and by certain liquid-vapor temperature conditions. The amount of deposition was found to be independent of time above 50 hr, suggesting that the reactions leading to crystal deposition reach an equilibrium condition in a relatively short time. Large temperature gradients in the capsules governed the location of the deposits. The transferred material tended to deposit preferentially on the hottest surfaces, rather than solution-precipitation. Though it is recognized that a refluxing capsule is a dubious model of a potassium boiler-condenser-turbine loop, the findings of this study suggest that mass transfer might not be serious in such a loop if the potassium charge and metal surfaces are as free of oxygen as possible. Author

N67-19603*# General Electric Co., Cincinnati, Ohio. Space Power and Propulsion Section.

POTASSIUM CORROSION STUDIES

R. G. Frank *In* AEC AEC–NASA Liquid Metals Inform. Meeting 23 Apr. 1965 p 272–315 refs (See N67-19581 09-17) CFSTI: HC $3.00/MF $0.65

(Contracts NAS3-2140; NAS3-2534; NAS3-2547; NAS3-6012)

The aim of the corrosion investigations is to advance the technology underlying the development of turboelectric space power generating systems. Although the corrosion investigations have included studies with potassium, sodium, and cesium, the fluid receiving the major attention is potassium. The following corrosion programs are described: 1) 5,000- and 10,000-hr refluxing potassium tests of advanced niobium containment alloys, 2) refluxing potassium compatibility tests between Nb–1Zr alloy and Mo–TZM alloy, 3) refluxing potassium stress-corrosion tests with D-43 alloy, 4) isothermal potassium compatibility tests between Nb–1Zr alloy and potential journal bearing materials, 5) isothermal potassium compatibility tests between Nb–1Zr alloy and stainless steel, 6) natural convection and forced circulation liquid sodium loop tests, and 7) forced circulation boiling potassium loop tests. Author

N67-19604*# Oak Ridge National Lab., Tenn. Metals and Ceramics Div.

REFRACTORY METAL-BOILING POTASSIUM COMPATIBILITY STUDIES

J. R. Di Stefano and D. H. Jansen *In* AEC AEC–NASA Liquid Metals Inform. Meeting 23 Apr. 1965 p 316–322 refs (See N67-19581 09-17) CFSTI: HC $3.00/MF $0.65

A test program, involving refluxing capsules, natural-circulation loops, and forced-circulation loops, to characterize the behavior of advanced refractory metal alloys in boiling potassium is discussed. Tests are described which were conducted to provide quantitative data on the rates of dissolutive attack by potassium as a function of temperature and condensing rate. The conditions and results of boiling-potassium capsule and loop tests operated with refractory

metals are presented in tabular form. Metallographic examination of boiler and condenser sections from the refluxing capsule tests disclosed no evidence of dissolutive attack, and the expected weight losses in the condensing region, reflecting dissolution of the alloy by the condensing vapor, were not realized. Test results are presented in tabular form, as well as results of metallographic examination of the test section components. L.E.W.

N67-19605*# MSA Research Corp., Callery, Pa.
FACTORS AFFECTING THE COMPATIBILITY OF LIQUID CESIUM WITH CONTAINMENT METALS
F. Tepper and J. Greer *In* AEC AEC–NASA Liquid Metals Inform. Meeting 23 Apr. 1965 p 323–333 (See N67-19581 09-17) CFSTI: HC $3.00/MF $0.65
(Contract AF 33(657)-9168)

A study made to assess the factors affecting the corrosion of structural metals by liquid cesium is summarized, and details are given on the following aspects: solubility of carbon in cesium, metal solubility studies, reflux capsule investigations, and dissimilar metal tests. Procedures used for the analysis of carbon in cesium are outlined, as well as the sampling procedure and oxygen analysis. The solubility of carbon in cesium was determined to 1200°F and the effect of carbon on the melting point of cesium was also examined. Data derived from metal solubility tests using tip capsules are presented in tabular form. Cesium boiling refluxing tests were performed with a number of alloys including L-605, TD–Ni, Mo–1/2Ti, Nb–1Zr, Ta–10W, and Nb–27Ta–12W–1/2Zr. Summary details are given on dissimilar metal studies performed at 1800°F in the case of L-605 and TD–Ni, and in the range 2100° to 2500°F for refractory metal alloys. L.E.W.

N67-19606*# Hughes Aircraft Co., Culver City, Calif. Aerospace Group.
SYNOPSIS OF CESIUM COMPATIBILITY STUDIES
P. M. Winslow *In* AEC AEC–NASA Liquid Metals Inform. Meeting 23 Apr. 1965 p 334–336 (See N67-19581 09-17) CFSTI: HC $3.00/MF $0.65

Investigations on the compatibility of metallic materials and ceramics with gaseous and liquid cesium, for ion engine applications, are summarized. Most of the tests were static capsule tests for 500 hours at 400°C in both liquid and vapor environments, and were made in triplicate. Weight change, metallographic examination, visual examination, mechanical properties, and spectrographic analysis of cesium were evaluated. Results with the individual metal and ceramics are described in detail. Among the general results found are: platinum and platinum iridium were not considered suitable for exposure to cesium; rather high degradations of volume resistivities of the ceramics were indicated; and no significant corrosion of the most materials was observed. N.E.N.

N67-19607*# Battelle Memorial Inst., Columbus, Ohio.
REFRACTORY METALS IN 1370–1870°C CESIUM VAPOR
J. A. DeMastry and N. M. Griesenauer *In* AEC AEC–NASA Liquid Metals Inform. Meeting 23 Apr. 1965 p 337–343 Sponsored by AF (See N67-19581 09-17) CFSTI: HC $3.00/MF $0.65

The corrosion resistance to cesium vapors was determined for tungsten, W–15Mo, W–25Re, TZM, Ta–12W, and Nb–5Mo–5V–1Zr. Specimens about a half-inch long were loaded into a TZM corrosion capsule, melted cesium was inserted, and the capsules were then heat treated in a vacuum resistance furnace for 100 or 1000 hours. Unalloyed tungsten was not attacked by cesium vapors. The W–15Mo alloy was not attacked during 100 hours but was severely attacked during 1000 hours at 3400°F. The W–25Re alloy exhibited the most resistance of the tungsten alloys to attack. The TZM alloy had outstanding resistance to the vapor attack. The Ta–12W specimens were not corroded after 100 hours, but showed severe surface dissolution after 1000 a hours at 2500°F, and the Nb–5Mo–5V–1Zr alloy was more resistant than the Ta–12W alloy. It was felt that tungsten and tungsten–base alloys should be useful thermionic emitters up to 3100°F, and TZM up to 3400°F. N.E.N.

N67-19610*# Pratt and Whitney Aircraft, Middletown, Conn. CANEL Div.
CORROSION STUDIES OF REFRACTORY METAL ALLOYS IN BOILING POTASSIUM AND LIQUID NAK
In AEC AEC–NASA Liquid Metals Inform. Meeting 23 Apr. 1965 p 374–393 refs (See N67-19581 09-17) CFSTI: HC $3.00/MF $0.65

Compatibility evaluations were made in gravity-feed potassium loops at temperatures up to 2000°F on the following materials: Nb-1 Zr, PWc-533 (C–Mo–Nb–Ti–Zr) PWC-11 (C-Nb-Zr), Type 316 stainless steel, and No-TZM. The evaluations were based on weight changes, chemical analyses, metallographic examinations, and mechanical strengths. A study was also made of interactions of Nb-1 Zr specimens in a Type 316 stainless steel-eutectic NaK loop operated at 1250°F. NSA

N67-19611*# Pratt and Whitney Aircraft, Middletown, Conn. CANEL Div.
CRITIQUE OF SESSION ON CORROSION BY BOILING ALKALI METALS
K. J. Kelly *In* AEC AEC–NASA Liquid Metals Inform. Meeting 23 Apr. 1965 p 394–397 (See N67-19581 09-17) CFSTI: HC $3.00/MF $0.65

Conference papers on boiling alkali metal programs are summarized, and increased development of alkali metals for Rankine and thermionic power conversion applications are reported. Areas of improved techniques are stressed, and observations which appeared preeminent are outlined. N.E.N.

N67-19619# Library of Congress, Washington, D. C. Aerospace Technology Div.
AGING OF BERYLLIUM–CHROMIUM AND BERYLLIUM–ZIRCONIUM ALLOYS Foreign Scientific and Technical Literature
Frances Mc Dowell 25 Aug. 1966 7 p refs Transl. into ENGLISH from Fiz. Metal. I Metalloved. (USSR) v. 21., no. 5, 1966 p 785–786
(ATD-66-104; AD-64-284) CFSTI: HC $3.00/MF $0.65

The work presents the results of research on the processed aging in beryllium allovs containing 0.3% Cr or 0.3% Zr, prepared from distilled beryllium (99.95%) and electrolytic chromium (99.7%) or iodide zirconium (99.9%). An analysis of these results confirms the conclusion reached earlier that almost complete precipitation of Cr from the matrix occurs during aging. In the case of Be-Zr alloy zirconium apparently not only completely precipitates from the matrix, but also promotes precipitation of other impurities.
Author (TAB)

N67-19628# Atomic Energy Commission, Washington, D. C.
STABILITY OF THERMOELECTRIC MATERIALS IN A HELIUM–GRAPHITE ENVIRONMENT
R. L. Bennett, H. L. Hemphill, W. T. Rainey, Jr., and G. W. Keilholtz *In its* High Temp. Thermometry Mar. 1966 4 p (See N67-19621 09-22) CFSTI: HC $3.00/MF $0.65

Reported are results of thermoelectric stability tests of thermocouple materials which were performed at 760°C (1400°F) and 982°C (1800°F) in stainless steel containers with a flowing atmosphere of helium containing 10 to 15 ppm CO and H_2 and in the presence of either AGOT graphite or Si–SiC coated AGOT graphite. Analyzed were nickel-containing metals, refractory metals, and platinum-containing metals. In addition, similar wires were exposed at each temperature to a flowing helium atmosphere. In many cases the emf errors were greater in those wires exposed

to pure helium than in those exposed to graphite. After exposure to carbonaceous atmospheres at 750°C, the following wires were in error less than 0.55% at 420°C: Chromel-P, Special Chromel-P, Special Alumel, Geminol-P, molybdenum, Ni–18% Mo, Pt–5% Mo, Geminol-N, and tungsten. The platinum–rhodium alloys were in error 0.5 to 1.0% and were the only wires which developed greater errors in the presence of silicon. In exposures to carbonaceous atmospheres at 982°C only the Ni-18% Mo and tungsten wires were in error less than 0.5% at 420°C. Results demonstrated the superiority of Special Alumel and Geminol-N over Regular Alumel under test conditions. The independence of thermoelectric change and physical damage of some of the metals was illustrated by tungsten and rhenium. It is concluded that the presence of Si–SiC coating on AGOT graphite is not particularly detrimental at 760°C to thermoelectric stability of the metals tested except for pure platinum. S.C.W.

N67-19655*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

FABRICATION OF BERYLLIUM. VOLUME V: THERMAL TREATMENTS FOR BERYLLIUM ALLOYS

R. F. Williams and S. E. Ingels Jul. 1966 69 p ref Prepared in part by Lockheed Missiles and Space Co.

(Contract NAS8-11798)

(NASA-TM-X-53453) CFSTI: HC $3.00/MF $0.65

This report documents the thermal treatment techniques investigated and evaluated for possible application in the fabrication of beryllium aerospace vehicle structures. The effects of time and temperature on the removal of residual stresses, induced by prior work, are evaluated. The physical, mechanical, and dimensional changes resulting from varying the rates of rapid cooling are reported; and the effects of prolonged exposures at high temperatures on the mechanical properties of beryllium sheets are investigated. R.LI.

N67-19729# Marine Engineering Lab., Annapolis, Md.

HEAT TREATMENT AND MECHANICAL PROPERTIES OF Ti-7Al-2.5 MO ALLOY

A. G. S. Morton Nov. 1966 32 p refs

(MEL-265/66; AD-642977) CFSTI: HC $3.00/MF $0.65

A production heat of Ti-7Al-2.5Mo in 1- and 2-inch plate thickness was evaluated. Mechanical properties were found to be uniform throughout the plates. Heat treatment studies showed that the 0.2 percent offset yield strength could be increased from 109 to 127 ksi while still maintaining adequate toughness. Mechanical properties in the heat-treated condition are reported. The Ti-Al-Mo family of alloys are strong candidates in the Titanium Hull Program, and additional work on this system is currently under way. Author (TAB)

N67-19744# Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.

REDUCTION OF CAVITATION DAMAGE BY SURFACE TREATMENT Final Report, Oct. 1964–Oct. 1965

John F. Ripken Jul. 1966 38 p refs *Its* Proj. Rept.-81

(Contract Nonr-710(64))

(AD-642842) CFSTI: CH $3.00/MF $0.65

A rationale and selected experimental evidence indicate that surface outgassing may contribute significantly to erosive damage in metals exposed to a cavitation environment. The possibility of inhibiting outgassing and consequent cavitation erosion by suitable surface treatments is experimentally examined. Tests of various surface treatments on an ASME type vibratory test apparatus failed to disclose significant benefits except in the case of a work hardening steel treated by shot peening. It is concluded that Poulters earlier findings on protective films do not hold for metals exposed in a high intensity cavitation test facility. Author (TAB)

N67-19755# Naval Research Lab., Washington, D. C.

INITIAL EVALUATIONS OF METALLURGICAL VARIABLES AS POSSIBLE FACTORS CONTROLLING THE RADIATION SENSITIVITY OF STRUCTURAL STEELS

J. R. Hawthorne and L. E. Steele 29 Sep. 1966 40 p refs Presented at the 3d Intern. Symp. on the Effects of Radiation on Structural Mater., Atlantic City, Jun. 1966 Submitted for publication

(Contract AT(49-5)-2110)

(NRL-6420; AD-642290) CFSTI: HC $3.00/MF $0.65

Experimental investigations for the isolation and assessment of metallurgical factors causing variable radiation embrittlement sensitivity of reactor structural steels were undertaken, using both large-tonnage commercial heats and special laboratory heats of steel. Metallurgical variables being evaluated include the identity and quantity of major alloying elements and of residual elements, steel-making practice--both melting (refining) and heat treatment practice, microstructure, and gas content. Experimental results from the initial series of the exploratory screening studies demonstrate that the radiation sensitivity of a steel can be altered appreciably through heat treatment practices and that microstructure plays a dominant, if not the most influential, role in radiation sensitivity development. A tempered martensite structure was noted to be generally less radiation sensitive than tempered upper bainite and ferrite structures. The data also indicate that vacuum melting and the minimization of residual element content yields steels having a superior irradiation performance compared with steels produced by conventional open hearth melting. However, long-term stress relieving heat treatments were not found to alter the irradiation response of A302-B steel. Author (TAB)

N67-19811# Springfield Armory, Mass.

SPUTTERING INTERMEDIATES ON TITANIUM TO IMPROVE ADHESION OF ELECTRODEPOSITED CHROMIUM

Francis X. Hassion 19 Apr. 1966 21 p refs

(SA-TR18-1097; AD-642780) CFSTI: HC $3.00/MF $0.65

Intermediate layers of chromium, nickel, and/or iron have been sputtered on titanium substrates. In the latter cases, upon subsequent chromium electrodeposition, adherence was localized and nonuniform. Chromium electrodeposits on chromium intermediate-sputtered layers, however, were uniform and adherent as indicated by bend tests. Experimental procedures are described and results are discussed. Author (TAB)

N67-19823# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

METHODS OF IMPROVING THE HEAT-RESISTANT PROPERTIES OF MATERIALS

I. A. Oding and P. V. Zuberev 24 Aug. 1966 10 p refs Transl. into ENGLISH from the Russian

(FTD-TT-66-111; AD-643726) CFSTI: HC $3.00/MF $0.65

The improvement in the heat resistance of steels and alloys, i.e., the increasing of the period of service at elevated temperatures and lowering the rate of creep in the second area proves to be one of the timely problems in modern metallurgy. The combining of plastic deformation with heat treatment, and also the radiating of metals with nuclear particles create premises for considerable improvement in heat-resistant properties. TAB

N67-19864* Aerojet-General Corp., Sacramento, Calif.

CHARACTERIZATION OF FATIGUE-CRACK GROWTH BY STRESS-WAVE EMISSION Final Report

C. E. Hartbower, W. W. Gerberich, and P. P. Crimmins 7 Jun. 1966 105 p refs

(Contract NAS1-4902)

(NASA-CR-66303) CFSTI: $3.00 CSCL 11F

Fatigue crack propagation in two steel alloys was investigated using the elastic waves emanating from the propagating crack front to monitor cycle-by-cycle growth. The research was conducted

in two phases: (1) fatigue crack propagation in pure bending using 18% nickel maraging steel and (2) crack propagation in tension–tension fatigue of 8×24-in. panels of D6aC low-alloy steel. A new technique for monitoring crack growth was utilized consisting of piezoelectric accelerometers in conjunction with an amplifying recording system to detect the stress wave emission. Electron fractography was also employed to assist in establishing fatigue crack growth mechanisms. Fatigue crack growth was verified to be a discontinuous process with marked differences between the materials and material conditions investigated. Relationships were established between the SWE associated with fatigue crack growth and several metallurgical and loading variables. A tentative model for the mechanism of fatigue crack growth in an oblique shear mode, and relationships between SWE and crack growth rate were also established. Author

N67-19891*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
METALLURGICAL AND GEOMETRICAL FACTORS AFFECTING ELEVATED-TEMPERATURE TENSILE PROPERTIES OF DISCONTINUOUS-FIBER COMPOSITES
Donald W. Petrasek, Robert A. Signorelli, and John W. Weeton Washington, NASA, Mar. 1967 29 p refs
(NASA-TN-D-3886) CFSTI: HC $3.00/MF $0.65 CSCL 11F

The length–diameter ratio and the orientation of the fibers in discontinuous-fiber-reinforced composites were correlated to their elevated-temperature tensile properties. The composites were made of copper and a copper–2%-chromium alloy reinforced with tungsten fibers having various length–diameter ratios. These composites were tested in tension at 300°, 900°, and 1500°F, and the results compared with continuous-length-fiber-reinforced composites containing the same matrix materials and fiber contents. The fiber orientation in the composite was extremely critical at elevated temperatures. Shear failures occurred at 1500°F for specimens in which the fibers were misalined from the tensile axis by as little as 3°. They also had significantly lower tensile strengths than composites having fibers alined parallel to the tensile axis. Tensile strengths of discontinuous-fiber-reinforced composites in which the fibers were alined parallel to the tensile axis were dependent upon the length–diameter ratio of the fibers in the composite. As the length–diameter ratio of the reinforcing fibers decreased, the tensile strengths of the composites decreased. Alloying the copper matrix with chromium increased the matrix shear strength. The greater the shear strength, the higher the load transfer capabilities of the matrix. Thus, the tensile strength of composites with a copper–2%-chromium matrix was higher than that of unalloyed-copper-matrix composites having the same fiber content and the same length–diameter-ratio fibers. Author

N67-19948*# Cornell Univ., Ithaca, N. Y. Dept. of Engineering Physics.
FIRST STEPS IN THE OXIDATION OF A (110) NICKEL SURFACE
L. H. Germer, J. W. May, and R. J. Szostak [1966] 27 p refs
(Grant NGR-33-010-029; Contract AISI-148)
(NASA-CR-82951) CFSTI: HC $3.00/MF $0.65 CSCL 11F

Oxygen is initially adsorbed upon a (110) nickel surface with unit sticking probability. At 1/3 coverage there are two different phases. At room temperature there is a well ordered (3×1) structure, which agglomerates at 300°C into a poorly organized (2×1) structure. Between 1/2 and 2/3 coverage at 300°C there is a set of superstructures of gradually increasing oxygen content, made up of (2×1) and (3×1) units uniformly distributed within repeating sequences. This behavior is quite different from the disorder found in this range when adsorption takes place at room temperature. When oxygen is removed from the surface by hydrogen at 300°C, sharp superstructure spots are seen in the reverse order until the surface is clean. Author

N67-19959*# TRW Equipment Labs., Cleveland, Ohio.
GENERATION OF LONG TIME CREEP DATA OF REFRACTORY ALLOYS AT ELEVATED TEMPERATURES Quarterly Report, 26 Jul.–26 Sep. 1966
J. C. Sawyer and E. A. Steigerwald 14 Oct. 1966 107 p refs
(Contract NAS3-2545)
(NASA-CR-82815; QR-13) CFSTI: HC $3.00/MF $0.65 CSCL 11F

Materials, procedures, and results are presented of creep tests conducted on vapor deposited tungsten, tantalum base alloy T-111, and the molybdenum base alloys TZC and TZM. The tests are being conducted to obtain creep design data on refractory metal alloys for use in advanced space power systems. Also included are thermocouple drift data, and results of a vacuum chamber residual gas analysis. R.N.A.

N67-19961*# Massachusetts Inst. of Tech., Cambridge. Dept. of Metallurgy
RESEARCH ON MECHANISMS OF ALLOY STRENGTHENING. I. ALLOY STRENGTHENING BY FINE OXIDE PARTICLE DISPERSION. II. THE SPLAT COOLING PROCESS FOR ALLOY DEVELOPMENT
Nicholas J. Grant Dec. 1966 12 p
(Grant NsG-117-61)
(NASA-CR-82972) CFSTI: HC $3.00/MF $0.65 CSCL 11F

The processing and extrusion of five iron–beryllium alloy powders are discussed along with the production of Cu–Al_2O_3 powders of approximately 44 microns diameter by a liquid atomization technique. Chromium oxide control in oxidation resistant oxide dispersion strengthened alloys is reported, and consideration is given to the internal oxidation of thin nickel–aluminum foils. Modes of deformation and fracture in oxide dispersed metal systems are summarized, and it is reported that an oxidation treatment was selected for the internal oxidation of 1/8 inch thick, cold rolled, dilute copper–aluminum alloys. The splat cooling process for alloy development was investigated, and includes the development of continuously operating atomization units for large scale powder production. Included are studies of (1) the decomposition of supersaturated Al–Si alloys, (2) dendritic spacing in aluminum alloys, (3) solubility limits of Al–Cu, Al–Ni, and other binary systems, and (4) copper base alloy systems. C.T.C.

N67-19962*# National Bureau of Standards, Washington, D. C.
THE EFFECT OF SURFACE REACTIONS ON FATIGUE FAILURE Final Report
T. R. Shives and J. A. Bennett [1967] 18 p refs
(NASA Order R-14)
(NASA-CR-82971; NBS-9488) CSCL 11F

The effects of oxygen and water vapor on the fatigue properties of titanium alloy Ti-4Al-4Mn and vacuum melted AISI 4340 steel were investigated by means of rotating beam tests of unnotched specimens in four environments; dry helium, dry air, moist helium, and moist air. The fatigue strength of both alloys was lower in moist environments than in dry environments. Oxygen was detrimental to the fatigue strength of both alloys only in the absence of water vapor. A large number of the steel specimens failed due to fatigue cracks having origins below the specimen surface. Author

N67-19971# National Gas Turbine Establishment, Pyestock (England).
RANDOM AND SYSTEMATIC FACTORS IN THE SCATTER OF CREEP DATA
K. F. A. Walles Jul. 1966 17 p refs
(NGTE-R-280)

The study of scatter in creep is facilitated by using a previously developed formula to provide mean values of creep properties. The distributions of the scatter in the temperature for which a given stress acting for a given time would produce a given strain (or rupture) are based on the Gaussian (normal error) form, but

they are often multimodal and can be resolved into two or more component distributions. Multimodal distributions show regularities in that, for a given composition, the standard deviation in temperature and the mean spacing in temperature between components is the same in each component distribution and each cast. It appears that multivalued creep occurs in particular ranges of stress and temperature, which can correspond to regions of low ductility. The present study of Nimonics 80, 80A and 90, and of 18-12-Nb steel supports the previous agreement of the formula with experimental data in finer detail and further validates the formula as a means of extrapolation. Author

N67-19974# National Gas Turbine Establishment, Pyestock (England).
A CONVENIENT REPRESENTATION OF CREEP STRAIN DATA FOR PROBLEMS INVOLVING TIME-VARYING STRESSES AND TEMPERATURES
J. M. Clarke Sep. 1966 24 p refs
(NGTE-R-284)

An empirical approach to the representation of observed creep strain behavior for a wide range of times, stresses, and temperatures is outlined. The formulae are unusual in permitting the representation of primary and tertiary creep behavior without forfeiting the convenience of explicit expressions for the strain rate using either the strain or time hardening redistribution calculations. A comparison is made between the usual expressions for stress dependence. A table lists the arbitrary constants chosen to fit the creep behavior of the Nimonic alloys 80A, 90, 100, and 105. Author

N67-19989* Aeronca Mfg. Corp., Middletown, Ohio.
DEVELOPMENT OF HIGH STRENGTH, BRAZED ALUMINUM, HONEYCOMB SANDWICH COMPOSITES ADAPTABLE FOR BOTH ELEVATED AND CRYOGENIC TEMPERATURE APPLICATIONS. VOLUME II: MANUFACTURING AND TESTING Final Report, Jul. 1964–Sep. 1966
B. E. Kramer and D. Y. Potter 30 Sep. 1966 187 p
(Contract NAS8-5445)
(NASA-CR-82927; ER-986, Vol. II) CFSTI: $3.00 CSCL 11F

A testing program for the fluxless brazing of high strength aluminum alloys is presented. Results for three honeycomb sandwich panels exhibited a high degree of retention of the base metal properties through the temperature range of −423°F to 600°F. In particular, the flatwise tension and peel strengths were superior to adhesive bonded configurations. It was concluded that optimum brazing alloy wetting and flow required the brazing alloy clad onto the substrate metal. The experimental results from quenching and heat treating studies showed that aluminum honeycomb sandwich panels can be quenched into liquid nitrogen with minimum distortion. Brazing alloys of the systems Al–Ge–Si–Zn and Al–Ge–Si–Ag were developed and showed promise for brazing a structure at a temperature of approximately 1000°F. As in other reactive brazing systems, certain limits exist for the minimum material thickness that can be joined. The best applications for brazed aluminum honeycomb sandwich would be for heavily loaded applications requiring thick facings with high core densities. S.P.

N67-19997*# General Electric Co., Cincinnati, Ohio Space Power and Propulsion Section.
ADVANCED REFRACTORY ALLOY CORROSION LOOP PROGRAM Quarterly Progress Report, 15 Jul.–15 Oct. 1966
R. W. Harrison, ed. and E. E. Hoffman 24 Oct. 1966 33 p refs
(Contract NAS3-6474)
(NASA-CR-72177; QPR-6) CFSTI: HC $3.00/MF $0.65

Status of a program to fabricate, operate for 10,000 hours, and evaluate a potassium corrosion test loop constructed of T-111 (Ta-8W-2Hf) alloy is presented. Materials for evaluation in the turbine simulator included Mo-TZC and Cb-132M. Data are presented for the microhardness and grain size of unannealed and annealed T-111 alloy and also for the longitudinal microstructure of T-111 alloy tubing. Data are also tabulated for the chemical analyses and mechanical properties of Cb-132M alloy. An annealing treatment is discussed for the Mo-TZC alloy, and alkali metal purification and handling is briefly described. A study to evaluate the corrosion resistance of two advanced tantalum alloys to potassium and lithium is described. S.P.

N67-20010*# General Electric Co., Philadelphia, Pa. Missile and Space Div.
INVESTIGATION OF THE REINFORCEMENT OF DUCTILE METALS WITH STRONG, HIGH MODULUS DISCONTINUOUS BRITTLE FIBERS Quarterly Report
A. Gatti, J. M. Berry, J. J. Gebhardt, and E. Feingold 10 Mar. 1967 32 p refs
(Contract NASw-1543)
(NASA-CR-82998; QR-1) CFSTI: HC $3.00/MF $0.65 CSCL 11F

Preliminary results from a program to define and investigate the critical factors affecting the reinforcement of ductile metals with short, brittle fibers are presented. The materials system selected for study is aluminum (or its alloys) reinforced with B_4C fibers or whiskers. Details are given on the following: (1) growth of B_4C whiskers by a chemical vapor deposition process, (2) testing of the matrix metal in uniaxial tension, (3) pulling of individual tungsten-core filaments of boron carbide in tension and a statistical study of their strength and elastic modulus, (4) use of a hot-pressing technique to fabricate single filament composites consisting of B_4C/W filaments imbedded in the pure aluminum, (5) fracture behavior of single filament composites, and (6) fracture behavior of single-filament composite specimens made at increasing test temperatures so that the fracture mode of the filament could be observed as a function of the decreasing shear strength of the matrix. Author

N67-20013*# General Electric Co., Cincinnati, Ohio. Space Power and Propulsion Section.
EVALUATION OF HIGH STRENGTH COLUMBIUM ALLOYS FOR ALKALI METAL CONTAINMENT Final Report, 25 Jul. 1962–15 Dec. 1964
L. B. Engel, Jr. and R. G. Frank 15 Dec. 1964 100 p refs
(Contract NAS3-2140)
(NASA-CR-82995; R66SD3015) CFSTI: HC $3.00/MF $0.65 CSCL 11F

Corrosion testing of four reflux capsules, two AS-55, one Nb–1Zr, and one D-43, containing purified potassium, was conducted at 2000°F for 10,000 hr in an ultrahigh vacuum chamber and a vacuum in the 10^{-8} to 10^{-9} torr range was maintained throughout testing. The condensing rate of the potassium contained within capsules was approximately 37 ± 12 lb/hr/ft^2. Evaluation of the Nb–1Zr alloy capsule after exposure revealed a small amount of black deposit, accompanied by a gold discoloration of the metal around or near the deposits. These black deposits were identified as essentially pure zirconium with a high oxygen content; some niobium was also present. Evaluation of the AS-55 alloy capsule revealed discoloration but the extent was significantly less than that found in the Nb–1Zr alloy capsule. An improved potassium transfer system was employed to fill the second AS-55 alloy capsule and the D-43 alloy capsule, and no signs of staining were observed. Chemical analyses revealed no significant mass transfer of carbon with either the AS-55 or D-43 alloy. Author

N67-20165# Royal Aircraft Establishment, Farnborough (England).
A PRELIMINARY INVESTIGATION OF HIGH RATE COMPACTION OF POWDERS USING THE PETROFORGE
R. C. Fullerton-Batten Apr. 1966 24 p refs
(RAE-TR-66136) CFSTI: HC $3.00/MF $0.65

Some experiments are described on the high rate compaction of copper and Cu–MoS_2 powders. A comparison is made between the properties of the resulting compacts and those for compacts prepared by slow pressing. The high rate process gives green compacts of higher density and hardness, but entrapped air causes cracking and deformation during subsequent heat treatment. Compacting in vacuum should help to overcome this disadvantage. Author

N67-20173# Naval Civil Engineering Lab., Port Hueneme, Calif.
CORROSION OF MATERIALS IN HYDROSPACE Technical Report, Mar. 1962–Jun. 1966
Fred M. Reinhart Dec. 1966 117 p refs
(R-504; AD-644473) CFSTI: HC$3.00/MF$0.65

A total of 1,590 specimens of 107 different alloys were exposed at depths of 2,340, 5,300, and 5,640 feet at two sites in the Pacific Ocean for 197, 1,064, and 123 days to determine the effects of deep ocean environments on the corrosion of materials. The corrosion rates, pit depths, types of corrosion, changes in mechanical properties, and analyses of corrosion products of the alloys are presented. Titanium alloys and two nickel base alloys (Ni-Fe-Cr-825 and Ni-Mo-Cr-C) were immune to corrosion. The corrosion rates of copper alloys and steels decreased with a decrease in the oxygen concentration of the seawater and with increasing time of exposure at a nominal depth of 5,500 feet. The corrosion rates of most of the aluminum alloys increased with increasing time of exposure and with decreasing oxygen concentration of seawater. Muntz metal, and nickel-manganese bronze were attacked by dezincification and aluminum bronze by dealuminification. All the stainless steels except types 316 and 316L, 20-Cb and 17 Cr - 7 Ni - 0.7 Ti- 0.2 Al were attacked by pitting corrosion. Only two precipitation hardened stainless steels were susceptible to stress corrosion cracking. The oceanographic parameters varied with depth. Changes in temperature and oxygen concentration exerted the most influence on the corrosion of the alloys. Author (TAB)

N67-20181# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
STUDYING THE OXIDATION OF Ni_3Al–Ni_3Nb ALLOY SYSTEMS
M. P. Arbuzov and V. G. Chuprina 29 Aug. 1966 13 p refs Transl. into ENGLISH from Izv. Vysshikh Uchebn. Zavedenii, Fiz. (Tomsk), no. 1, 1964 p 93–98
(FTD-HT-66-129; TT-67-60321; AD-644166) CFSTI: HC $3.00/MF$0.65

The heat resistance of alloys, working at high temperatures, depends in a considerable degree upon the alloying components, introduced into these alloys. A majority of heat resistant alloys of industrial value have a nickel base, whereby, many of them are alloyed with aluminum and niobium. This time greater attention has been attracted by the problem of creating heat resistant alloys on the basis of intermetallic compounds. TAB

N67-20217# General Electric Co., Schenectady, N. Y. Knolls Atomic Power Lab.
FATIGUE DESIGN DATA FOR THE TITANIUM ALLOY, Ti–6Al–6V–2Sn
D. F. Mowbray 20 May 1966 29 p refs
(Contract W-31-109-ENG-52)
(KAPL-3158) CFSTI: HC$3.00/MF$0.65

An investigation was conducted to determine some of the basic fatigue properties of the Ti-base alloy (Ti–6Al–6V–2Sn) in the annealed bar stock form. The basic S–N curves in the cyclic life region from approximately 10^2 to 10^6 cycles, the effect of mean stress at lives from 10^4 to 10^6 cycles, and the effect of notches on fatigue strength at 10^6 cycles were established at room temperature and at 600°F. The test results indicate that this material possesses good unnotched fatigue strength, but has a rather high sensitivity to mean stress and notches. These latter results are as expected because of the material's high ratio of yield to ultimate tensile strength. The test results were analyzed in terms of current design methods. It was found that the effect of mean stress on the unnotched fatigue strength is best described by a parabolic damage law. Values of δ are established for estimating fatigue notch factors for members containing crack-like defects. Author (NSA)

N67-20306# Royal Aircraft Establishment, Farnborough (England).
DIFFUSION IN METALS IN GENERAL AND ALUMINUM AND ITS ALLOYS IN PARTICULAR: A BIBLIOGRAPHY
Janet Dudley, comp. London, Min. of Aviation, Nov. 1966 22 p refs
(RAE-LIB-BIBL-265) CFSTI: HC$3.00/MF$0.65

This bibliography contains references to books, reports and periodical articles concerning diffusion published between 1960 and 1966. These references were found in Nuclear Science Abstracts, A.S.M. Review of Metal Literature, Metallurgical Abstracts, NASA Star, Science Abstracts B, Abstracts Journal of Metallurgy A and B, B.N.F.M.R.A. Bulletin, and Chemical Abstracts. They are arranged in alphabetical order of authors in two sequences: Diffusion in Metals in General and Diffusion in Aluminium and its Alloys. Author

18 MATERIALS, NONMETALLIC

Includes corrosion; physical and mechanical properties of materials (e.g., plastics); and elastomers, hydraulic fluids, etc. For basic research see: 06 Chemistry. For related information see also: 17 Materials, Metallic; 27 Propellants; and 32 Structural Mechanics.

N67-19541# Naval Civil Engineering Lab., Port Hueneme, Calif.
EFFECT OF PHOTODEGRADATION ON ATTENUATED TOTAL REFLECTANCE SPECTRA OF ORGANIC COATINGS Technical Report, Jun. 1964–Sep. 1966
Peter J. Hearst Sep. 1966 32 p refs
(R-479; AD-640733) CFSTI: HC$3.00/MF$0.65

Clear and pigmented films of various coating vehicles were irradiated in air with a mercury arc and with a xenon arc. Attenuated total reflectance (ATR) spectra were obtained before and after the irradiations in an attempt to find an accelerated test method for determining coating performance. The coatings included alkyd, vinyl-alkyd, partially hydrolyzed vinyl copolymer, vinyl copolymer, epoxy-amine, and epoxy-polyamide films. Although the mercury-arc irradiations produced considerable effects on the ATR spectra of clear vehicle films, the xenon-arc irradiations produced comparatively negligible effects. Whereas the observable effects of mercury-arc irradiations on pigmented films were less than on clear films, the reverse was true with the xenon-arc irradiations, which produced appreciable effects only on some of the pigmented films. These differences in results may be related primarily to the spectral distribution of the irradiating light and to the resultant differences in penetration and reflection within the film. ATR spectroscopy may prove to be useful in an accelerated method for determining deterioration in pigmented organic coatings, but it does not appear useful for clear films. Author (TAB)

N67-19577# Vermont Univ., Burlington.
ON THE FRACTURE ENERGY OF GLASS
J. O. Outwater and D. J. Gerry 29 Aug. 1966 17 p refs
(Contract Nonr-3219(01)(X))
(AD-640848) CFSTI: HC$3.00/MF$0.65

The fracture energy of glass has been measured at crack velocities ranging from 10 to the minus 7th power to 0.01 cms. per sec. both in normal air and in various environments. It shows

no minumum value but decreases logarithmically as the velocity gets less. The effects of repeated loading on the crack propagation rate are strongly dependent on the frequency of the loading. These results differ from the effects in metals where the crack propagation rate is substantially independent of the loading frequency and are in accord with predictions based on the theory of glass acting as a ductile material. Author (TAB)

N67-19738# Harvard Univ., Cambridge, Mass. Cruft Lab.
TRANSMISSION ELECTRON MICROSCOPY OF THIN GLASS SAMPLES
T. P. Seward, III, D. R. Uhlmann, D. Turnbull, and G. R. Pierce Sep. 1966 28 p refs
(Contract Nonr-1866(50))
(TR-9; AD-643229) CFSTI: HC $3.00/MF $0.65

Two techniques for preparing thin glass samples for direct transmission electron microscopy, viz. mechanical thinning and fracturing are discussed. A modification of the Doherty and Leombruno procedure for mechanically thinning ceramic materials is described. These techniques make possible more reliable electron microscope studies of fine scale submicrostructure in glass systems. Electron microscope observations on fused silica, an alkali-borosilicate glass, and some binary silicate glasses are reported and discussed in terms of our present understanding of glass structure. Author (TAB)

N67-19819# Whittaker Corp., San Diego, Calif. Narmco Research and Development Div.
HIGH-TEMPERATURE STRUCTURAL RESINS Final Report, 18 Oct. 1965–17 Jul. 1966
Paul M. Hergenrother and Harold H. Levine Jul. 1966 44 p refs
(Contract NOw-660144-c)
(AD-642043) CFSTI: HC $3.00/MF $0.65

The report summarizes an investigation directed toward the synthesis and evaluation of thermally stable polymers for potential use in fabricating rocket and missile components, and devices requiring deep submergence for long periods of time. Research was concentrated on three aromatic polyheterocyclics, the polyquinoxalines, the polybenzothiazoles, and a novel hybrid polymer, the phenyl-subetituted polyquinoxalines. Major emphasis was placed on fabrication of laminates as large as 9 in. x 12 in. x 14 plies, and adhesive bonds from prepreg and tape prepared from stable m-cresol solutions of the polyquinoxalines. Excellent test results were obtained. Polybenzothiazole research also centered on fabrication work which provided 14-ply laminates having high individual flexural strengths and moduli. The successful preparation of an A-B monomer, 3-amino-4-mercaptobenzamide, was accomplished; this was subsequently polymerized to yield poly(2,5-benzothiazole) having polymer decomposition temperatures in air and in helium of 600C and 675C respectively. Novel phenyl-substituted polyquinoxalines were prepared via melt and solution polymerization to yield polymers which exhibited outstanding oxidative stability. A phenyl-substituted diether polyquinoxaline exhibited only a 7% weight loss under isothermal aging at 371C in air after 100 hours and clear, tough, yellow films exhibiting good flexibility were cast from m-cresol solutions. Author (TAB)

N67-19875* Ilikon Corp., Natick, Mass.
THE DEVELOPMENT OF DISPERSION-STRENGTHENED NICKEL–CHROMIUM OXIDATION RESISTANT ALLOYS Summary Report
R. Grierson, L. J. Bonis, R. Rogers, and H. L. Levingston 11 Jul. 1966 57 p refs
(Contract NAS3-7279)
(NASA-CR-54523; E-3806) CFSTI: $3.00 CSCL 11F

A method of stabilizing certain dispersed phases in a metal matrix was developed. Using this method, an alloy containing 2–8 volume percent of aluminum–titanium oxide with a particle size of less than 0.1 micron and a particle spacing of about 0.3 to 1 micron was to be prepared from −325 mesh powder of a nickel base alloy containing 20.3 weight percent chromium and 3.2 weight percent titanium plus aluminum in a weight ratio of approximate 1:1. In this alloy the specified distribution was not produced throughout the alloy with any consistency with the standard STAP treatments employed. A coarse oxide appeared on the surface of the individual powder particles. Author

N67-19967 English Electric Aviation, Ltd., Luton (England).
THE EVALUATION OF HEAT SHIELD PLASTICS FOR HIGH SPEED AIRCRAFT TRANSPARENCIES
O. R. Ballard, S. U. Craig, and F. A. Pilbeam Jun. 1966 29 p refs
(D-MAT-136)

A number of materials considered suitable for application as heat shields for high speed aircraft transparencies are evaluated. The materials tested were: polycarbonate, epoxy RX.35/D.D.S., epoxy RX.35 with 5 parts/hundred resin trimethoxyboroxine (T.M.B.), epoxy RX.35 with 6-1/2 parts/hundred trimethoxyboroxine (T.M.B.), and poly-N-vinyl carbazole. Properties evaluated were mechanical, thermal, and optical. It is concluded that although the materials tested do not offer an immediately available replacement for existing heat shield materials, polycarbonate and RX.35/D.D.S. are considered to show most promise, but further development work is indicated. Author

N67-19996*# Whittaker Corp., San Diego, Calif. Narmco Research and Development Div.
THE DEVELOPMENT OF STRUCTURAL ADHESIVE SYSTEMS SUITABLE FOR USE WITH LIQUID OXYGEN Annual Summary Report, 1 Jul. 1965–30 Jun. 1966
Jerome Hollander, Floyd D. Trischler, and Edward S. Harrison Jul. 1966 143 p refs
(Contract NAS8-11068)
(NASA-CR-82922; ASR-3) CFSTI: HC $3.00/MF $0.65 CSCL 11A

Six new highly halogenated polyurethanes, two new polyethers, two new polycarbonates, and one new polyester have been synthesized. In addition, five polyurethanes prepared previously were synthesized again. Most of these polymers were tested for liquid oxygen (LOX) compatibility. The results indicate that urethanes based on 0,0-dihydroperfluoroalcohols are stable to impact in LOX if the nitrogen atom is also attached to a 1,1-dihydroperfluoroalkyl chain, but lack LOX stability if attached to a nonfluorinated alkyl chain or a benzyl methylene group. The results also indicate that the specimen thickness seems to have no effect on the LOX sensitivity of compatible polyurethanes. A new polyether from chloropentafluoroisopropyl alcohol was LOX compatible. Polycarbonates and nonfluorinated aromatic-based polyesters were shown to be LOX incompatible. Three interesting polyether systems were synthesized which show real promise of being converted into hydroxyl-terminated prepolymers. These polyethers were prepared from hexafluorobenzene and hexafluoropentanediol, from chloropentafluoroisopropyl alcohol, and from the reaction of a fluoroalkyl polycarbonate with sulfur tetrafluoride. Preparations and synthetic studies were carried out on a number of additional monomers and intermediates. Author

N67-20182# Massachusetts Inst. of Tech., Cambridge. Fibers and Polymers Div.
RESEARCH STUDY ON COLD DRAWING PHENOMENA IN HIGH POLYMERS Final Report, Jan. 1964–Jan. 1966
R. D. Andrews, Jr., S. W. Allison, D. H. Ender, R. M. Kimmel, and W. Whitney Natick, Mass., Army Natick Labs., Aug. 1966 174 p refs
(Contract DA-19-129-AMC-238(N))
(COM-25; TR-67-10-CM; AD-644021) CFSTI: HC $3.00/MF $0.65

A fundamental study of the phenomenon of cold-drawing (plastic yield) in polymers has been carried out, through which a better understanding of several of the features of this process has been achieved. The effects of temperature, thermal history, stress-field, chemical structure and pre-orientation on the stress-strain behavior of both glassy and crystalline polymers have been explored. The behavior of several polymers, particularly polystyrene and polymethyl methacrylate, in stress relaxation, relation-recovery cycling and creep, especially with respect to delayed drawing, was investigated in detail. The geometry of neck formation has been quantitatively investigated by photographic techniques, and volume changes during compression have been measured using a mercury dilatometer. Microscopic modes of yielding, particularly the formation of deformation bands, are described. Birefringence changes during deformation of polyacrylonitrile under various conditions and during hot and cold extension of polystyrene and polymethyl methacrylate are presented and related to the molecular processes believed to be occurring. The development of a molecular theory of drawing is attempted through three different paths of approach: (1) a defect model analogous to dislocations, (2) a mathematical model of the fiber bundle type, and (3) a description in terms of the breakdown of secondary intermolecular cohesive bonding. General conclusions and recommendations for future studies in these areas are presented. Author (TAB)

N67-20327# Royal Aircraft Establishment, Farnborough (England).
EFFECTS OF RADIATION ON A SILICONE FLUID
C. J. Savage Sep. 1966 14 p ref
(RAE-TR-66300) CFSTI: HC $3.00/MF $0.65

The effects of radiation on a proposed gyroscope damping fluid were studied. The effects of gamma radiation on the viscosity of the fluid are described, together with a quantitative and qualitative analysis of the gases evolved during irradiation. An attempt has also been made to determine the minimum radiation dose necessary to produce bubbles of gas in a sealed container of the fluid. Author

N67-20331# Royal Aircraft Establishment, Farnborough (England).
THE FRICTION AND WEAR OF CARBON FIBRE-REINFORCED POLYESTER RESIN
R. F. Fullerton-Batten and J. K. Lancaster Aug. 1966 19 p refs
(RAE-TR-66247) CFSTI: HC $3.00/MF $0.65

Experiments are described which examine the effect of reinforcement by carbon fibers on the friction and wear of polyester resin sliding either against itself or tool steel. It is shown that reinforcement can significantly reduce both the coefficient of friction and the rate of wear, the maximum effect being achieved when the fiber axes are oriented normal to the sliding surface. In these conditions it is suggested that the fibers act as preferential load-bearing contact regions. Author

19 MATHEMATICS

Includes calculation methods and theory; and numerical analysis. For applications see: 08 Computers.

N67-19540# Emmanuel Coll., Boston, Mass. Oriental Science Library.
ON THE GENERALIZATION OF SOME SUM RULES IN RACAH ALGEBRA
Chen Jin-quan Bedford, Mass., AFCRL, Oct. 1966 7 p refs Transl. into ENGLISH from Wu li Hsueh Pao (Peking), v. 21, no. 10, 1965 p 1817–1820
(Contract AF 19(628)-5073)
(EMM-66-83; TT-66-60348; AD-644564) CFSTI: HC $3.00/MF $0.65

Translation of Chinese research on the generalization of some sum rules in Racah algebra. TAB

N67-19567# Carnegie Inst. of Tech., Pittsburgh, Pa. Management Sciences Research Group.
A PSEUDO PRIMAL-DUAL INTEGER PROGRAMMING ALGORITHM
Fred Glover (Calif. Univ., Berkeley) Dec. 1966 32 p refs Prepared in cooperation with Calif. Univ.
(Contract Nonr-760(24))
(RR-90; AD-644557) CFSTI: HC $3.00/MF $0.65

The Pseudo Primal-Dual Algorithm solves the pure integer programming problem in two stages, systematically violating and restoring dual feasibility while maintaining an all-integer matrix. The algorithm is related to the Gomory All-Integer Algorithm and the Young Primal Integer Programming Algorithm, differing from the former in the dual feasible stage by the choice of cuts and pivot variable, and from the latter in the dual infeasible stage by the use of a more rigid (and faster) rule for restoring dual feasibility. The net advance in the objective function value produced by the algorithm between two consecutive stages of dual infeasibility is shown to be at least as great as that produced by pivoting with the dual simplex method. Example problems are given that illustrate basic features and variations of the method. Author (TAB)

N67-19620# California Univ., Berkeley. Dept. of Mathematics.
SEMINAR ON FIBER SPACES
Emery Thomas 1966 53 p refs
(Grant AF-AFOSR-336-63)
(AFOSR-66-2025; AD-640905) CFSTI: HC $3.00/MF $0.65

Contents: Introduction; Principal Fiber Spaces; The classical method of decomposing a fibration; Oriented sphere bundles; Killing homotopy groups; An illustration; and Computing Postnikov invariants. TAB

N67-19681# RAND Corp., Santa Monica, Calif.
LOCAL BEHAVIOR OF STATIONARY GAUSSIAN PROCESSES
M. B. Marcus Oct. 1966 59 p refs
(Contract AF 49(638)-1700; Proj. RAND)
(RM-5139-PR; AD-641323) CFSTI: HC $3.00/MF $0.65

The local behavior is found for a wide class of separable, stationary Gaussian processes. In most cases, the processes considered are those with covariances that are convex in (0, d) for some d > 0. Analogues are found to the well-known results for Brownian motion, the law of the iterated logarithm, and Paul Levys uniform Holder condition. Author (TAB)

N67-19683# California Univ., Los Angeles. Western Management Science Inst.
THE APPLICATION OF A NONLINEAR PROGRAMMING ALGORITHM TO A SECOND ORDER REPRESENTATION OF THE PROBLEM
G. W. Graves and A. B. Whinston Sep. 1966 23 p refs *Its* Working Paper No. 108
(Contract Nonr-233(75))
(AD-641198) CFSTI: HC $3.00/MF $0.65

Recently several algorithms have been presented for the solution of nonlinear programming problems. Examples of such work are the procedures of Rosen, Zoutendijk, Fiacco and McCormick, and Graves. In contrast to the amount of theoretical activity, relatively little work has been published on the computational aspects of the algorithms. This paper describes some computational experiments in the area of nonlinear programming. Specifically, working within the framework of an algorithm developed by G. Graves, the authors shall compare the convergence using only first derivatives with the convergence obtained when the algorithm is applied to an expanded natural second order form of the problem requiring second derivatives. First they provide a general

description of the nonlinear algorithm with a proof of convergence. Next they give a natural second order form of the problem. Finally, the computational results for four nonlinear problems recently circulated by A. R. Colville of I.B.M. are presented. Author (TAB)

N67-19686# Cornell Univ., Ithaca, N. Y. Dept. of Industrial Engineering and Operations Research.

THE MARKOV PROCESS ANALYSIS OF LUCHAK'S QUEUEING MODEL

Narahari U. Prabhu and Atma P. Lalchandani Sep. 1966 18 p refs

(Contract Nonr-401(55); Grant NSF GP-3783)

(TR-16; AD-643533) CFSTI: HC $3.00/MF $0.65

Customers arrive in a Poisson process at a single-server queueing system and demand a random number of phases of service, each phase requiring a negative exponentially distributed time. This system is analyzed by considering the bivariate Markov process formed by the queue-length and the number of residual service phases of the customer at the counter. Author (TAB)

N67-19692# Harvard Univ., Cambridge, Mass. Div. of Engineering and Applied Physics.

THE SADDLE POINT METHOD OF APPROXIMATING EXTREME VALUE PROBABILITIES

Paul Trafton Oct. 1966 68 p refs

(Contract Nonr-1866(16))

(TR-510; AD-643228) CFSTI: HC $3.00/MF $0.65

The saddle point method of asymptotic analysis has been used to approximate the probability of extreme values of a random variable assuming that its characteristic function is known. In particular, the author examines the extreme value probabilities of Gaussian and chi square random variables in detail. Also, he applies the saddle point method to determine false alarm probabilities at the output of systems of the form: filter-squarer-filter with a stationary Gaussian input. The results obtained for this problem lead to a better understanding of post-detection filtering. In addition, use is made of a theorem from the theory of Toeplitz forms. This theorem allows us to obtain useful approximations for the characteristic function of square law systems with finite time integrators as the post-nonlinear filter. He inverts these Toeplitz characteristic functions exactly in some cases and in other cases he uses the saddle point method. Graphs of extreme value probabilities obtained both from closed form Toeplitz approximations and by computer evaluation of saddle point approximations are presented. Also, some results obtained by experimental simulation of certain square law systems are presented. Generally speaking, the saddle point method appears to be in error by less than 1 - 2% for probabilities smaller than 10 to the -2. Author (TAB)

N67-19694# Wisconsin Univ., Madison. Mathematics Research Center.

SOME REMARKS ON THE STABILITY OF ITERATION PROCESSES

O. V. Zenkin May 1966 17 p refs Transl. into ENGLISH from Zh. Vychislitel'noi Mat. i Mat. Fiz. (Moscow), v. 4, 1964 p 745–748

(Contract DA-11-022-ORD-2059)

(MRC-TSR-663; TT-67-60124; AD-642889) CFSTI: HC $3.00/MF $0.65

The numerical stability and accuracy of the ordinary iterative procedure for solving linear algebraic systems of equations are considered in the paper, the effects of round-off error and the use of digital numbers of finite length being taken into account. The results are applied to the approximate solution of the Dirichlet problem for Poissons equation by a simple finite-difference scheme. Author (TAB)

N67-19697# Wisconsin Univ., Madison. Mathematics Research Center.

COMPUTATION OF THE PROPER VALUES OF A MEMBRANE BY A FINITE-DIFFERENCE METHOD

L. Veidinger Jul. 1966 24 p refs Transl. into ENGLISH from Zh. Vychislitel'noi Mat. i Mat. Fiz. (Moscow), v. 4, 1964 p 1037–1044

(Contract DA-11-022-ORD-2059)

(MRC-TSR-664; TT-67-60126; AD-642883) CFSTI: HC $3.00/MF $0.65

Two-sided error estimates are found for approximate proper values of plane membranes found by finite-difference methods. TAB

N67-19698# Wisconsin Univ., Madison. Mathematics Research Center.

ITERATIVE METHODS OF SOLVING A NONLINEAR EQUATION BASED ON LINEARIZATION BY THE NEWTON INTERPOLATION FORMULA

S. Ul'm Aug. 1966 17 p refs Transl. into ENGLISH from Izv. Akad. Nauk Eston. SSR, Ser. Fiz.-Mat. i Tekhn. Nauk (Tallinn), v. 12, 1963 p 384–390

(Contract DA-11-022-ORD-2059)

(MRC-TSR-680; TT-67-60128; AD-642911) CFSTI: HC $3.00/MF $0.65

Two theorems are provided concerning convergence of iterative processes for solving nonlinear operator equations in which each step involves approximate linearization by a process analogous to linear interpolation. Author (TAB)

N67-19699# Wisconsin Univ., Madison. Mathematics Research Center.

INVESTIGATION OF A NONLINEAR SINGULAR EQUATION WITH HILBERT KERNEL

H. S. Muhtarov Oct. 1966 17 p refs Transl. into ENGLISH from Izv. Vysshikh Uchsb. Zavedenii, Mat. (Moscow), no. 2(45), 1965 p 118–125

(Contract DA-31-124-ARO(D)-462)

(MRC-TSR-707; TT-67-60123; AD-642921) CFSTI: HC $3.00/MF $0.65

Theorems on the existence and uniqueness of solutions of a singular nonlinear integral equation are proved. TAB

N67-19700# Wisconsin Univ., Madison. Mathematics Research Center.

UPON THE DIAGONAL SEQUENCES OF THE PADE TABLE

P. Wynn May 1966 11 p refs

(Contract DA-11-022-ORD-2059)

(MRC-TSR-660; AD-642892) CFSTI: HC $3.00/MF $0.65

It is shown that if one of the diagonal sequences of the Pade table converges then, subject to a certain condition, the diagonal sequences at one remove from the convergent sequence must also converge. The convergence behaviour of the Pade table is also examined in the case in which a convergent diagonal sequence is neighbour to an oscillating sequence. Author (TAB)

N67-19702# Wisconsin Univ., Madison. Mathematics Research Center.

TRANSFORMATIONS TO ACCELERATE THE CONVERGENCE OF FOURIER SERIES

P. Wynn Jul. 1966 58 p refs

(Contract DA-11-022-ORD-2059)

(MRC-TSR-673; AD-642916) CFSTI: HC $3.00/MF $0.65

The paper offers a comparative review of methods for accelerating the numerical convergence of Fourier series. The various reasons for which Fourier series either diverge or converge sufficiently slowly to render them useless for computation are discussed and where possible an appropriate convergence

acceleration transformation is prescribed. Particular emphasis is placed upon the use of continued fractions, which appears at the same time to have the widest domain of application and to be the most powerful general method available. Author (TAB)

N67-19705# Wisconsin Univ., Madison. Mathematics Research Center.

A NOTE ON PLK-METHOD

Ken-iti Takahasi Sep. 1966 22 p refs

(Contract DA-31-124-ARO(D)-462)

(MRC-TSR-703; AD-642914) CFSTI: HC $3.00/MF $0.65

Initial value problems for the case when the degree of the polynomial alpha (u) is greater than two are studied with the aid of the PLK-method (method of strained coordinates). TAB

N67-19721# Wisconsin Univ., Madison. Mathematics Research Center.

REMARKS ON OPTIMAL CONTROL. I: THE STANDARD SUFFICIENCY THEORY FOR THE LEAST TIME PROBLEM

L. C. Young May 1966 34 p

(Contract DA-11-022-ORD-2059)

(MRC-TSR-654; AD-642887) CFSTI: HC $3.00/MF $0.65

The sufficiency theory treated in the report concerns a least time problem of optimal control in which the suspected solutions, which obey a strengthened form of the Pontryagin maximum principle, cover a certain set E in n-space in a particular manner that we describe. The set E need not be a domain, and the covering need not be simple. In spite of this, we are able to develop a theory similar to that of Caratheodory in the classical calculus of variations. This theory is, however, now valid in the large, and in circumstances which differ rather radically from those which occur in the classical case. The main tools are a greatly strengthened theorem of Malus on the one hand, and the use, on the other hand, of a new and more powerful Hilbert independence integral, whose integrand is now, in effect, many-valued. The very general situations, to which the theory is applicable, require moreover, many new concepts and definitions, which are, in part, of a topological nature, and which make it possible to avoid restrictions to one-to-one maps with non-singular Jacobians, restrictions which are normally made in the calculus of variations, but which would here be quite out of place. Author (TAB)

N67-19732# Wisconsin Univ., Madison. Mathematics Research Center.

A PARAMETRIC METHOD FOR SOLVING CERTAIN NONCONCAVE MAXIMIZATION PROBLEMS

K. Ritter Jun. 1966 21 p refs

(Contract DA-11-022-ORD-2059)

(MRC-TSR-655; AD-642900) CFSTI: HC $3.00/MF $0.65

A maximization problem with linear inequality constraints and different kinds of nonconcave objective functions is considered. By means of parametric quadratic programming the solution of the original problem is reduced to the determination of the absolute maximum of a continuous function of one variable on a bounded interval. Author (TAB)

N67-19737# Wisconsin Univ., Madison. Mathematics Research Center.

APPROXIMATIONS OF CONTINUOUS FUNCTIONS BY POLYGONAL FUNCTIONS

T. N. E. Greville and J. Barkley Rosser Nov. 1966 12 p refs

(Contract DA-31-124-ARO(D)-462)

(MRC-TSR-682; AD-642912) CFSTI: HC $3.00/MF $0.65

Sufficient conditions on a pair of functions in an interval are obtained so that all continuous functions in the interval can be approximated in a continuous way to any preassigned accuracy by piecewise linear combinations of the two. Author (TAB)

N67-19741# Wisconsin Univ., Madison. Mathematics Research Center.

TWO ADDITION THEOREMS

H. B. Mann Jul. 1966 9 p refs

(Contract DA-11-022-ORD-2059)

(MRC-TSR-681; AD-642906) CFSTI: HC $3.00/MF $0.65

Two addition theorems on Abelian groups are proved. One of these results in a considerable simplification of the proof of a theorem of Erdos, Ginzburg and Ziv. Author (TAB)

N67-19742# Information Research Associates, Inc., Lexington, Mass.

DIGITAL SIMULATION OF THE WIENER CANONICAL EXPANSION

Donald B. Brick, Henry Kashian, Larry W. Petri, and Mary E. Robinson Jul. 1966 55 p refs

(Contracts AF 49(638)-1631; AF 33(615)-3758)

(TR-7; IRA-102-4; IRA-107-3; AD-642712) CFSTI: HC $3.00/MF $0.65

The numerical and programming aspects of a digital simulation of the Hermite-Laguerre (Wiener-Canonical) expansion of the likelihood function for a stochastic process are described as a first step in a computer investigation and evaluation of the Brick-Zames method of synthesizing Bayes Optimum Filters. Initial simulations are being conducted for the base-line cases of white-normal-noise and signal-plus-white-normal noise inputs. Present trial inputs are generated by Monte-Carlo methods. Numerical considerations governing the input process, the convergence of each Laguerre term, the processing time interval required for accurate approximation of the input process, convergence of the coefficients, and the Hermite polynomials are investigated. Where found necessary to investigate these, relevant computer diagnostic procedures are described. Initial results for the base-line processes, although preliminary, are discussed qualitatively. The next steps to be taken in the evaluation are also outlined. The computer programs, flow charts, and Fortran program listings are given in an Appendix. Various allowable forms of the Hermite-Laguerre expansion, the convergence properties of each, the relevant amplitude-scaling factors, and their relative advantages and disadvantages are considered in another Appendix. Author (TAB)

N67-19746# Wisconsin Univ., Madison. Mathematics Research Center.

A RUNGE–KUTTA FOR ALL SEASONS

J. Barkley Rosser Sep. 1966 53 p refs

(Contract DA-31-124-ARO(D)-462)

(MRC-TSR-698; AD-642910) CFSTI: HC $3.00/MF $0.65

Runge-Kutta methods of orders up to ten are given, with many fewer function evaluations than previously, and with means of estimating accuracy. Author (TAB)

N67-19747# Wisconsin Univ., Madison. Mathematics Research Center.

UPON AN INVARIANT ASSOCIATED WITH THE EPSILON ALGORITHM

P. Wynn Jul. 1966 17 p refs

(Contract DA-11-022-ORD-2059)

(MRC-TSR-675; AD-642917) CFSTI: HC $3.00/MF $0.65

An explicit formula is derived for an invariant associated with the epsilon-algorithm. Author (TAB)

N67-19753# Princeton Univ., N. J. Dept. of Electrical Engineering.

INTEGRAL REPRESENTATIONS FOR NONUNIFORM SAMPLING EXPANSIONS

A. H. Haddad and J. B. Thomas [1966] 13 p refs Presented at the 4th Ann. Allerton Conf. on Circuit and System Theory, 5–7 Oct. 1966
(Contract DA-31-124-ARO(D)-292; Grants NSF GK-187; NSF GP-1647)
(AD-642583) CFSTI: HC $3.00/MF $0.65

The paper investigates an integral representation, involving the Green's function of a boundary-value problem, for the derivation of sampling expansions. The representation is generalized to include non-self-adjoint boundary conditions, and resulting physical interpretation is emphasized. Two cases are considered in detail. The first order differential operator is treated with non-self-adjoint boundary conditions. The representation for this case yields periodically nonuniform and derivative sampling expansions, with corresponding system interpretations. The second order differential operator is further investigated. The general expression for the interpolating function is derived. Examples resulting in nonuniform sampling expansions are given. Further examples are discussed to illustrate the validity of the method for singular problems as well. Author (TAB)

N67-19765# Air Force Cambridge Research Labs., Bedford, Mass. Data Sciences Lab.
CATEGORIZATIONS AND REALIZATIONS OF POSITIVE REAL AND BIQUADRATIC IMMITANCE FUNCTIONS. PART II: PROGRAMMED REALIZATIONS
Kurt H. Haase Aug. 1966 198 p *Its* Phys. and Mathematical Sci. Res. Paper No. 215(II)
(AFCRL-66-243(II); AD-643158) CFSTI: HC $3.00/MF $0.65

Categorizations and realizations are applied to positive real and biquadratic immittance functions in nine numerical examples. Computation plans and routine computation procedures are developed predominantly for the use of desk calculating machines. This portion presents the application of a theory that has been discussed in AD-634 764, Categorizations and Realizations of Positive Real and Biquadratic Immittance Functions. The examples meet any possible occurrence of positive real and biquadratic impedance of the admittance function. Author (TAB)

N67-19766# Wisconsin Univ., Madison. Mathematics Research Center.
ASYMPTOTIC PROPERTIES OF THE SOLUTION OF THE CHARACTERISTIC EQUATION OF THE THEORY OF TRANSPORT OF RADIATION IN STRONGLY ABSORBENT MEDIA
M. V. Maslennikov and T. A. Sushkevich Apr. 1966 34 p refs Transl. into ENGLISH from Zh. Vychislitel'noi Mat. i Mat. Fiz. (Moscow), v. 4, no. 1, 1964 p 23–34
(Contract DA-11-022-ORD-2059)
(MRC-662; TT-67-60125; AD-642894) CFSTI: HC $3.00/MF $0.65

Approximate solutions are obtained for the integral equations of radiative transfer in strongly absorbent anisotropic media in which the index of scattering is expressible in terms of polynomials in the cosine of the scattering angle. Author (TAB)

N67-19769# Wisconsin Univ., Madison. Dept. of Statistics.
ASYMPTOTIC EFFICIENCY OF THE KOLMOGOROV–SMIRNOV TEST
Jerome Klotz Aug. 1966 17 p refs
(Grant AF-AFOSR-1158-66)
(TR-93; AD-641398) CFSTI: HC $3.00/MF $0.65

A simple derivation of asymptotic efficiency for the Kolmogorov–Smirnov statistic is given and evaluated for normal location and normal scale alternatives. Using equal samples to simply the derivation, the limiting efficiency is obtained by letting the type I error alpha go to zero while the type II error goes to beta, $0 < beta < 1$. For symmetric location alternatives, the efficiency is the same as that obtained for the Mood and Brown median test. Limits of relative efficiencies for alternatives which approach the null hypothesis are 2/pi for normal location alternatives and 1/(pi(E)) for normal scale alternatives. Author (TAB)

N67-19783# Wisconsin Univ., Madison. Mathematics Research Center.
ON A CONJECTURE OF HASSE CONCERNING MULTIPLICATIVE RELATIONS OF GAUSSIAN SUMS
Koichi Yamamoto Aug. 1966 26 p refs
(Contract DA-11-022-ORD-2059)
(MRC-TSR-676; AD-642915) CFSTI: HC $3.00/MF $0.65

Hasses conjecture over the multiplicative relations of Gaussian sums with e th power residue characters is confirmed when these sums are considered as ideals, and it is shown that the conjecture is false when these sums are considered merely as numbers. The Davenport-Hasse formula is transformed into a form analogous to the multiplication formula of the gamma function, and the Bernoulli polynomial of degree 1 defined over a cyclic group of finite order is the main tool to deal with the problem. Author (TAB)

N67-19784# Wisconsin Univ., Madison. Mathematics Research Center.
ON THE NUMERICAL SOLUTION OF A QUASI-LINEAR ELLIPTIC EQUATION
C. W. Cryer Jun. 1966 27 p refs
(Contract DA-11-022-ORD-2059)
(MRC-TSR-657; AD-642890) CFSTI: HC $3.00/MF $0.65

A boundary value problem for a quasi-linear elliptic equation is solved numerically. Author (TAB)

N67-19789# Stanford Univ., Calif. Systems Theory Lab.
SPECTRAL FACTORIZATION BY ALGEBRA
B. D. O. Anderson Sep. 1966 21 p refs
(Contract Nonr-225(83))
(SEL-66-086; TR-6560-6; AD-643119) CFSTI: HC $3.00/MF $0.65

The problem of giving a spectral factorization of a class of matrices arising in Wiener filtering theory and network synthesis is tackled via an algebraic procedure. A quadratic matrix equation involving only constant matrices is shown to possess solutions which directly define a solution to the spectral factorization problem. A spectral factor with a stable inverse is defined by that unique solution to the quadratic equation which also satisfies a certain eigenvalue inequality. Solution of the quadratic matrix equation and incorporation of the eigenvalue inequality constraint are made possible through determination of the eigenvectors of a matrix formed from the coefficient matrices of the quadratic equation. Author (TAB)

N67-19791# Johns Hopkins Univ., Baltimore, Md.
ON A FIXED-WIDTH CONFIDENCE INTERVAL FOR THE COMMON MEAN OF TWO DISTRIBUTIONS HAVING UNEQUAL VARIANCES. I: THE CASE OF ONE VARIANCE KNOWN
Leon J. Gleser and S. Zacks Nov. 1966 25 p refs Prepared Jointly with Kansas State Univ.
(Contract Nonr-4010(09); Grant NSF GP-6129)
(TR-58; AD-643182) CFSTI: HC $3.00/MF $0.65

Suppose that one has two measuring instruments, one generating a random variable X having mean m and variance S sub x, the other producing a random variable Y having mean m and variance S sub y. It is desired to find a fixed-width confidence interval of width 2d for m having probability of coverage g. Assuming that the cost for taking observations in the same for both measuring instruments, the problem becomes one of finding the most accurate measuring instrument and using it to construct the confidence interval. TAB

N67-19824# Research Analysis Corp., McLean, Va.
BAYESIAN ANALYSIS OF THE WEIBULL PROCESS WITH UNKNOWN SCALE PARAMETER
Richard M. Soland Aug. 1966 24 p refs
(Contract DA-44-188-ARO-1)
(RAC-TP-215; AD-643816) CFSTI: HC $3.00/MF $0.65

The Weibull process with unknown scale parameter is taken as a model for Bayesian decision making. The family of natural conjugate prior distributions for the scale parameter is exhibited and used in prior and posterior analysis. Preposterior analysis and several sampling schemes are then discussed. Preposterior analysis is given for a two-action problem with utility linear in the unknown mean of the Weibull process, in which the sampling scheme yields the first r failures in a life test of n items. An example is included.
Author (TAB)

N67-19832# Wisconsin Univ., Madison.
ON CANONICAL BASES OF IDEALS
Henry B. Mann and Koichi Yamamoto Sep. 1966 12 p
(Contract DA-31-124-ARO(D)-462)
(MRC-692; AD-642913) CFSTI: HC $3.00/MF $0.65

The integral basis omega 1,..., omega n of the algebraic number field F will be called canonical for the ideal A of F if d1 omega 1,...,dn omega n is a modul basis for A where d sub j are rational integers. In this paper the authors show: If A sub 1,...,A sub s are any s ideals of an algebraic number field F then there exists a basis which is canonical for each of the ideals A sub 1,...,A sub s.
Author (TAB)

N67-19833# Wisconsin Univ., Madison.
ON CLUSTERS OF ROOTS OF POLYNOMIAL EQUATIONS
A. M. Ostrowski Mar. 1966 16 p
(Contract DA-11-022-ORD-2059)
(MRC-629; AD-642897) CFSTI: HC $3.00/MF $0.65

Three theorems are given concerning the clusters of roots of a polynomial and of its derivative and in particular on the results analogous to those well-known in the case of multiple roots.
Author (TAB)

N67-19851# Stanford Research Inst., Menlo Park, Calif.
THE FAST FOURIER TRANSFORM
Richard C. Singleton Dec. 1966 45 p refs
(AD-643998) CFSTI: HC $3.00/MF $0.65

Good has proposed a fast algorithm for computing the complex Fourier transform x sub j = sum from k = o to N-1 of alpha sub k exp (i2 ps jk/N) for j = 0,1,... N-1, and Cooley and Tukey have restated the algorithm and reported major time savings in using it to compute large transforms on a digital computer. With N an integer power of two, computing time for this algorithm is proportional to N log2 N, a major improvement over other methods with computing time proportional to N(2). In this paper, the fast Fourier transform algorithm is discussed, and ALGOL procedures given for the basic method plus some of its variations. ALGOL procedures organized for efficient computing on a system with a virtual memory feature are given; these procedures reduce the need for moving portions of data arrays to and from high speed memory. A method for solving very large problems by use of auxiliary memory is also proposed. Methods of using the fast Fourier transform algorithm on real data are restated, and a way of reducing computing in this case is shown. A plan of scaling for computing the fast transform with fixed-point arithmetic is outlined; this method has been used on a small computer without floating-point hardware.
Author (TAB)

N67-19906* Georgia Inst. of Tech., Atlanta.
STUDY OF THE METHODS FOR THE NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS Final Report, 26 Jan. 1966–25 Jan. 1967
L. J. Gallaher, G. E. Duncan, O. B. Francis, Jr., J. M. Gwynn, Jr., H. G. Hale, Jr. et al 25 Jan. 1967 125 p refs
(Contract NAS8-20014; Proj. A-831)
(NASA-CR-82962) CFSTI: $3.00 CSCL 12A

A computer program was developed for the integration of ordinary differential equations. The Adams–Bashforth–Moulton method, the Stetter–Gragg–Butcher method, Cowell's method of constant Nth order differences, and the Runge–Kutta–Shanks method were used in developing the procedure. Information is provided on a satisfactory executive procedure developed to act in an administrative and bookkeeping capacity for the basic integration routines, plus a start and restart routine which contains a separate Runge–Kutta–Shanks routine. The Arenstorf orbits of the restricted three body problem, the linear differential equations associated with Fourier transforms, and the linear equations obtained from the partial differential equation for the vibrating string were used to exercise the procedure. The results of computer runs with a variety of problems and accuracies showed that no particular method seems exceptionally superior to any other. For the accuracy range used, certain orders of some methods were inappropriate, and for a given method one particular order usually dominated. Results proved the program's suitability as a general library program for integrating systems of differential equations.
R.N.A.

N67-19923* Florida State Univ., Tallahassee. Dept. of Statistics.
SIMULTANEOUS NONLINEAR ESTIMATION
John J. Beauchamp 1 Feb. 1967 218 p refs
(Grant NGR-10-004-029)
(NASA-CR-82967; TR-11) CFSTI: HC $3.00 CSCL 12A

Three nonlinear estimation procedures have been generalized for simultaneous application to a multiple equation regression model. The application of the generalized least squares procedure to the estimation of regression model parameters is shown, and the use of the generalized procedures in the analysis of compartmental models is demonstrated. Consideration is given to the asymptotic properties of the estimators, and a measure of efficiency of the estimators of the nonlinear parameters for generalized partial totals and generalized Spearman estimation procedures is defined. Numerical examples of the various estimation procedures are given and suggestions to aid experiment design in order to make the best use of these estimation procedures are given.
A.G.O.

N67-19937*# Kent State Univ., Ohio.
STOCHASTIC MODELS FOR MULTI-VALUED, MULTI-DIMENSIONAL RELATIONS Semiannual Status Report, Jun. 16, 1966–Jan. 15, 1967
Triloki N. Bhargava 11 Mar. 1967 19 p refs
(Grant NsG-568)
(NASA-CR-82934; SASR-6) CFSTI: HC $3.00/MF $0.65 CSCL 12A

Research activities in the areas of covered spaces, extension of Riemannian geometry, and maximal functions over partitions are described. The most fundamental difference discovered so far between covered and topological spaces is the structure of the open sets, or members of the collection of subsets of X. Several approaches to the question of extending the results of Riemannian geometry to more general spaces are being investigated with special interest in problems of a qualitative or global character and which are, therefore, closely related to generalizations of the calculus of variations.
A.G.O.

N67-20016# Johns Hopkins Univ., Baltimore, Md. Dept. of Statistics.
ON FINITE AND INFINITE SEQUENCES OF EXCHANGEABLE EVENTS
David G. Kendall (Cambridge Univ.) Dec. 1966 21 p refs
(Contract Nonr-4010(09))
(TR-64; AD-643860) CFSTI: HC $3.00/MF $0.65

Finite and infinite sequences of exchangeable events are reviewed from a unified point of view, and versions of a Poisson limit theorem are proved for both the finite and the infinite case. The paper concludes with two open problems. Author (TAB)

N67-20174# Harvard Univ., Cambridge, Mass. Dept. of Statistics.
APPROXIMATING THE BINOMIAL, F, AND COMMONLY USED RELATED DISTRIBUTIONS, II
John W. Pratt Aug. 1966 54 p refs
(Contract Nonr-1866(37); Grant NSF G-24035)
(TR-13; AD-643955) CFSTI: HC $3.00/MF $0.65

This paper describes and derives the asymptotic behavior of a new normal approximation and of a family of normal approximations based on roots, including square and cube root approximations. Various asymptotic comparisons are made, all of which rank the new approximation first, the cube root approximations second, and the other root approximations (and the ordinary normal approximation) third. For instance, in the binomial case, if the tail probability is fixed as $n \to \infty$, the errors resulting from the foregoing approximations are generally of order $n^{-3/2}$, n^{-1}, and $n^{-1/2}$ respectively, while for a tail probability approaching 0, the relative error in approximating it approaches 0 if the corresponding standard normal deviate is of smaller order than $n^{1/2}$, $n^{1/4}$, or $n^{1/8}$ respectively, but not generally otherwise. These comparisons are deduced from detailed results which are also given. Author

N67-20188# Center for Naval Analyses, Washington, D. C. Operations Evaluation Group.
THE LAGRANGE MULTIPLIER—A HEURISTIC PRESENTATION
W. R. Nunn 31 Oct. 1966 40 p refs /ts Res. Contrib. No. 76
(Contract Nonr-3732(00))
(AD-643740) CFSTI: HC $3.00/MF $0.65

Many problems in operations research require the maximization or minimization of a suitable payoff function subject to various constraints. Lagrange multipliers are classically used for this type of problem, however, the treatment given this technique by most texts requires that the payoff and constraint functions be at least differentiable at the extremizing point. This paper shows that the Lagrange multiplier concept can be independent of differentiability or even continuity of the functions involved. It also gives the reader a geometric insight into the workings of the multiplier. Simplifications possible, if the functions involved are homogeneous, are displayed. The treatment is heuristic rather than formally rigorous. Author (TAB)

N67-20312# Deutsche Versuchsanstalt fur Luft- und Raumfahrt, Oberpfaffenhofen (West Germany). Institut fuer Flugfunk und Mikrowellen.
CODING THEORY ON THE BASIS OF LINEAR ALGEBRA. PART I: LINEAR ALGEBRA [KODIERUNG AUF DER GRUNDLAGE DER LINEAREN ALGEBRA. TEIL I: LINEARE ALGEBRA]
Ludwig Harmann Dec. 1966 120 p refs In GERMAN; ENGLISH summary
(DLR-FB-66-81; DVL-574) CFSTI: HC $3.00/MF $0.65

Fundamental concepts of linear algebra which are essential to the theory of linear codes are reviewed. Covered are groups, fields, Galois fields, vector spaces, combinations, determinants, matrices, linear dependence of vectors, and systems of linear equations. Author

N67-20343# Wisconsin Univ., Madison. Mathematics Research Center.
SOME VARIATIONAL PRINCIPLES FOR A NON LINEAR EIGENVALUE PROBLEM
R. E. L. Turner Jun. 1966 20 p refs
(Contract DA-11-022-ORD-2059; Grant NSF GP-4316)
(MRC-678; AD-642918) CFSTI: HC $3.00/MF $0.65

Variational principles analogous to classical ones are exhibited for the eigenvalues of Ax - lambda 2 Bx - lambda x = 0, where A and B are compact, positive operators in a Hilbert space. Unlike the classical ones, they involve a nonquadratic form and both nonlinear and linear auxiliary conditions. Author (TAB)

N67-20345# White Sands Missile Range, N. Mex. Atmospheric Sciences Lab.
CONSIDERATION OF SOME PROBLEMS IN CURVE FITTING
Walter B. Miller Sep. 1966 38 p refs
(ECOM-5078; AD-642857) CFSTI: HC $3.00/MF $0.65

This report concerns a particular random process. Let X sub i iET be a family of independent normal random variables indexed by an interval T of real numbers. It will be further assumed that for each tET, V or (X sub t) = S, E(Xt) = P(t) for a continuous function P. A test is devised to determine for any integer k whether or not P(x) is a polynomial of degree k. If it is known that this is the case, estimators of P(t) are derived as well as an estimator of the leading coefficient of P. The methods of derivation parallel those of finite calculus and may be considered to constitute an error analysis of finite difference techniques used in interpolation, prediction, and curve fitting. Author (TAB)

20 METEOROLOGY

Includes climatology; weather forecasting; and visibility studies. For related information see also: 13 Geophysics; and 30 Space Sciences.

N67-19480# Emmanuel Coll., Boston, Mass. Oriental Science Library.
THE VERTICAL INFLUENCE OF DYNAMICAL DISTURBANCES BETWEEN THE STRATOSPHERE AND THE TROPOSPHERE
Yung-san Chen Oct. 1966 18 p Transl. into ENGLISH from Ch'i Hsiang Hsueh Pao (Peking), v. 31, no. 4, 1962 p 319-327
(Contract AF 19(628)-5073)
(EMM-66-66; TT-67-60349; AD-644565) CFSTI: HC $3.00/MF $0.65

The solution of the vertical velocity equation derived from the vorticity and thermodynamic equations with the stratospheric effect taken into consideration shows that the disturbances in the stratosphere with a longer wavelength can produce a slight effect on the troposphere but the effect of those with a shorter wavelength can hardly reach that part of the atmosphere. The effect of the disturbances in the troposphere with a longer wavelength on the stratosphere is greater than that in the stratosphere on itself. These effects are equal in the case of a shorter wavelength. TAB

N67-19517 Illinois State Water Survey, Urbana. Atmospheric Sciences Section.
RELATION OF LIGHTNING, RAINFALL, AND HAIL TO THE PROPERTIES OF MESOSCALE METEOROLOGICAL PATTERNS Progress Report
Pieter J. Feteris Nov. 1966 83 p refs
(Grant NSF GP-5196)
(PR-1)

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1. RELATION OF LIGHTNING, RAINFALL, AND HAIL TO THE PROPERTIES OF MESOSCALE METEOROLOGICAL PATTERNS P. J. Feteris p 1-48 refs (See N67-19518 09-20)

2. A VERIFICATION OF THE ACCURACY OF SHORT-RANGE LIGHTNING COUNTERS J. H. Boer (Meteorol. Office) p 49–59 refs (See N67-19519 09-20)

N67-19518 Illinois State Water Survey, Urbana. Atmospheric Sciences Section.

RELATION OF LIGHTNING, RAINFALL, AND HAIL TO THE PROPERTIES OF MESOSCALE METEOROLOGICAL PATTERNS

Pieter J. Feteris *In its* Relation of Lightning, Rainfall, and Hail to the Properties of Mesoscale Meteorol. Patterns Nov. 1966 p 1–48 refs (See N67-19517 09-20)

A diagnostic study of the production of rainfall, lightning discharges, and hail in convective storms, as related to a number of time-dependent meteorological variables, is described. The analytical approach is discussed; the data used were routine teletype meteorological data and reports made by volunteer observers in the Netherlands. The development of computer programs to expedite the preparation of surface and upper air maps and the computation of pattern characteristics is outlined. The light programs are tailored to an input of teletype data and are written in Fortran. Descriptions are given for the following programs: time cross-sections of wind, clouds, and weather; mapping of winds and pressure tendencies; display of cloud patterns and weather; surface temperature mapping; cross-correlation program for zero lag; precipitation analysis; equivalent potential temperature and waves; and thermal wind. A few preliminary analyses are presented, and, where appropriate, a part of the printout is shown, in either raw or analyzed form. L.E.W.

N67-19519 Illinois State Water Survey, Urbana. Atmospheric Sciences Section.

A VERIFICATION OF THE ACCURACY OF SHORT-RANGE LIGHTNING COUNTERS

J. H. Boer (Meteorol. Office, Woensdrecht, Neth.) *In its* Relation of Lightning, Rainfall, and Hail to the Properties of Mesoscale Meteorol. Patterns Nov. 1966 p 49–59 refs Submitted for publication (See N67-19517 09-20)

The instrumentation, observational techniques, and verification experiments used to determine the accuracy of short-range lightning counters are described. A circuit diagram of a modified version of the Pierce lightning counter is given, as well as the aerial set-up of the lightning counter. All observed flashes occurring in an isolated storm were plotted and compared with counted flashes; the results of 10 comparisons are summarized in tabular form. The data indicate that for most storms the counts at ranges below 15 km are accurate within 15%. The apparently high degree of accuracy of the short-range counters suggests that the parts of the field changes that trigger the counters have more or less equal intensity. This would indicate that the first return strokes of different multiple flashes transport approximately equal amounts of charge to earth. L.E.W.

N67-19547# Army Electronics Labs., Fort Monmouth, N. J. Atmospheric Physics Div.

BOUNDARY-LAYER METEOROLOGY AS DERIVED FROM REDUCTION OF THE FRIGORIMETER DATA. PART I: TEMPERATE ZONE

E. C. Taylor-Ellis Jul. 1966 40 p refs

(ECOM-2729; AD-640573) CFSTI: HC $3.00/MF $0.65

The automatic meteorological instrument, the Frigorimeter, and analyses of data from its use in temperate zones are presented for climatological values and Army usefulness. Reduction of data and presentation of results are descriptive of boundary-meterology in a temperate environment. Historical and theoretical review of the terms and units of measurements for the Frigorimeter together with the results of the data reduction has led to three recommendations: (1) Use of the term wind chill, also include T-W-P-R factor (temperature, wind, precipitation, and radiation) as an inclusive and descriptive term. (2) Use of the electrical term kilowatts per meter squared per hour as the actual variable in the sensor instrumentation rather than the bioclimatological limited term kilocalorie. (3) Use of the term Frigorimeter (Climatograph) as a more inclusive descriptive word for the sensor rather than only the coldness term. Sixty-four months of data from the Belmar, N. J. and Natick, Mass. areas have been reduced and analyzed. These data recommend the instrument as an effective and efficient sensor for acquiring boundary-layer composite values of wind chill (T-W-P-R factor) environment for climatological and Army use. Author (TAB)

N67-19560# Naval Civil Engineering Lab., Port Hueneme, Calif.

WIND DUCT STUDIES OF DRIFTING SNOW Technical Report, Oct. 1965–Jul. 1966

N. S. Stehle Oct. 1966 22 p refs

(R-488; AD-640967) CFSTI: HC $3.00/MF $0.65

Problems in logistics and maintenance resulting from blowing and drifting snow confront stations and operations in nearly all portions of the polar regions. Wind duct experiments were conducted in a cold chamber at the Naval Civil Engineering Laboratory to obtain knowledge of the mechanics of snow movement and deposition. These experiments showed that wind velocity and the availability of snow to the wind stream contribute most to the amount of snow deposition or erosion; temperature becomes influential only when the availability of snow is limited. In addition, snow movement is not significant at wind speeds less than 20 mph unless snow is already present in the wind stream. Tests using models in the present wind duct are recommended to provide an opportunity to study rapidly the characteristics of blowing and drifting snow around novel and unique structures and other facilities. These tests, coupled with field tests, would make possible study of the most promising shapes as well as the gross characteristics of drifting snow at heights greater than 2 feet and wind speeds greater than 20 mph. Author (TAB)

N67-19569# University Coll., London (England). Dept. of Physics.

DETERMINATION OF AIR DENSITY, TEMPERATURE AND WINDS AT HIGH ALTITUDES Annual Summary Report

G. V. Groves, R. N. Procunier, D. P. McDermott, and D. Rees Mar. 1966 55 p refs

(Contract AF 61(052)-781)

(AFCRL-66-637; SR-3; ASR-2; AD-640840) CFSTI: HC $3.00/MF $0.65

Techniques were developed for extending wind and temperature measurements to great heights. Grenade and TMA payloads used on Skylark, Nike-Cajun and Nike-Apache rockets are described. A multiplex system for acoustic recording comprising seven control frequencies amplitude modulated with pressure variations and ultra-violet and magnetic tape recording systems is also described. This system has the advantage of removing electrical noise encountered over long transmission lines and is capable of electronically reproducing signals. Its use has enabled the maximum altitude of detection of 355 gm grenades to be extended to 107 km. Details of F24 camera coverage and operation for the optical triangulation of grenades for the Sardinia firings in September 1965 are given. The development of specialised optical equipment is reviewed, and an analysis of data obtainated at Eglin AFB, Florida and at Sardinia during 1965 is given. A summary is presented of the theoretical developments necessary for the reduction of data, and the next stages of the research are discussed. TAB

N67-19668# White Sands Missile Range, N. Mex. Atmospheric Sciences Lab.

WIND SHEAR CALCULATIONS FOR SMALL SHEAR LAYERS

Manuel Armendariz and Laurence J. Rider Jun. 1966 24 p refs
(ECOM-5057; AD-641744) CFSTI: HC$3.00/MF$0.65

Wind shear computed from data obtained at Cape Kennedy using a Jimsphere wind sensor and an AN/FPS-16 radar to track the sensor is compared with wind shear computed from three other wind measuring systems: namely, rawinsonde, rocketsonde, and Contraves cinetheodolite. This comparison indicates that the Jimsphere winds were subjected to considerable smoothing. In particular, the slope of a line on a log-log representation depicting the exponential relationship between layer thickness and wind shear is found to decrease as the wind profile is smoothed. The observed wind shear for an 82-foot layer thickness (as derived from Jimsphere wind data) is compared with the theoretical value computed using an exponential relationship between wind shear and layer thickness. Differences are less than 0.2 foot/sec for the 82-foot layer approximately 75% of the time. Author (TAB)

N67-19672# Wisconsin Univ., Madison. Dept. of Statistics.
DISCRETE MODELS FOR FORECASTING AND CONTROL
George E. P. Box and Gwilym M. Jenkins (Lancaster Univ.) Jun. 1966 27 p refs Submitted for publication
(Grant AF-AFOSR-1158-66)
(TR-76; AD-641935) CFSTI: HC$3.00/MF$0.65

The authors first describe a class of discrete linear time series models capable of representing nonstationary as well as stationary behavior. In control problems these models are used to describe disturbances to the system. Dynamic models which represent relationships between variables which control and are controlled are later introduced. The identification, fitting, checking and practical use of such models in forecasting and control are discussed. The models employed are empirico-mechanistic in that while they can be interpreted as descriptions of physical phenomena having the right general character they do not claim to represent exact physical reality and are fitted to data empirically. An important principle in the choice of such models is that, they should, while adequately representing the data, contain the fewest possible number of parameters. This is called the principle of parsimony or of parsimonious parametrization. Author (TAB)

N67-19691# Hawaii Inst. of Geophysics, Honolulu.
MEAN WIND PROFILES 1956–1959 HAWAII AND THE CENTRAL PACIFIC, PART III Final Report
Hitoye M. Kakugawa and Carl W. Adams (Tokyo Univ.) 15 Aug. 1966 173 p ref Sponsored by Navy
(HIG-66-13; AD-643542) CFSTI: HC$3.00/MF$0.65

Mean-resultant wind profiles are presented by individual months averaged throughout the period 1956 through 1959 and by alternate year groupings for certain stations. Mean-resultant wind component percentage profiles are averaged on a seasonal basis for the entire period and by alternate year groupings for certain stations. Author (TAB)

N67-19719# Aeronautical Chart and Information Center, St. Louis, Mo. Linguistic Section.
APPLICATION OF MICROBAROMETRIC LEVELING DURING LARGE SCALE GRAVIMETRIC SURVEY IN MOUNTAIN-TAIGA TERRAIN [PRIMENENIYE MIKROBAROMIVELIROVANIYA PRI KRUP-NOMASCHTABNOY GRAVIMETRICHESKOY S'YEMKE V GORNO-TAYESHNOY MESTNOSTI]
A. K. Gordun, I. N. Kadyrov, L. L. Lyakhov, and G. A. Solov'yev Nov. 1966 9 p refs Transl. into ENGLISH from Izv. Vysshikh Uchebn. Zavedenii, Geol. i Razvedka (Moscow), v. 9, no. 4, 1966 p 136–138
(ACIC-TC-1132; TT-67-60178; AD-643481) CFSTI: HC $3.00/MF $0.65

The time from sunrise till 9-10 a.m. on the northern slopes and till 11-12 a.m. on the southern ones, as well as after 15-16 p.m., is most favorable for field observations. To reduce the distorting influence of pressure-and temperature-microfluctuations several readings should be taken on the instrument at one-minute intervals. Five-Seven readings should be taken at the fundamental points. Work should be discontinued during the periods of accelerated pressure changes, exceeding 0.8-1 torus/hour. In this case, moreover, an error of 1 min in time determination leads to errors of up to 0.5m. The temperature curves should be averaged, without taking into account the single splashes. Special attention should be paid to the determination of the value of the barometric degree. Author (TAB)

N67-19725# American Meteorological Society, Boston, Mass.
PROGRAM AND TECHNIQUES OF ATMOSPHERIC TURBULENCE RESEARCH ON MOUNTAINOUS HELICOPTER ROUTES [PROGRAMMA I METODIKA ISSLEDOVANIIA ATMOSFERNOI TURBULENTNOSTI NA GORNYKH VERTOLETNYKH TRASSAKH]
P. A. Vorontsov Bedford, Mass., AFCRL, Oct. 1966 28 p refs Transl. into ENGLISH from Tr. Gl. Geofiz. Observ. (Leningrad), no. 171, 1965 p 20–31
(Contract AF 19(628)-3880)
(T-R-630; TT-67-60155; AD-643360) CFSTI: HC $3.00/MF $0.65

A study was made: (a) to generalize the available experience in aviation weather forecasting for helicopter flights, (b) to study atmospheric turbulence on mountainous routes with specially equipped helicopters and airplanes and with passenger helicopters, (c) to discuss flight conditions on a given route with the flight personnel, and (d) to have the forecasters of the Aviation Weather Stations servicing helicopter flights engage in a study of the flight conditions on the route and in a refinement of the existing operating instructions on the forecasting of buffeting. TAB

N67-19726# Indiana State Univ., Terre Haute.
MAXIMUM HOURLY DURATIONS OF HIGH AND LOW TEMPERATURES Final Report
Jane Westbrook and John C. Hook [1964] 22 p refs
(Contract DA-19-129-AMC-366(N))
(AD-643361) CFSTI: HC$3.00/MF$0.65

A method for predicting the most probable duration of high and low temperatures from the absolute maximum and absolute minimum was developed. The method is applicable for any temperature, any month, any place in the world. It was the purpose of this contract to make extensive tests of the method and make modifications if necessary. The tests were conducted using actual data on temperature durations from United States (including Alaska) and Canadian stations for January and July of 1961, 1962, and 1963 and from fifteen other stations all over the world for July for as long as they had been keeping records of durations. The tests were made by comparing the actual durations with those predicted by the model. For low temperatures (-40F, -30F, -20F) the prediction method performs almost perfectly. For high temperatures (110F, 100F, 90F) the method has a tendency to overpredict the durations. This can be remedied by assuming a maximum value of 20 hours duration for temperatures of 110F and 100F and above, and by using the predicted values for a mean year or for one year in five for temperatures of 90F and above. For temperatures of 80F and above there is close agreement between the actual and predicted temperature durations. Author (TAB)

N67-19736# Army Electronics Labs., Fort Monmouth, N. J.
FLAGSTAFF CLOUD PHYSICS PROGRAM METEOROLOGICAL REVIEW, JULY AND AUGUST 1966
E. M. Frisby Sep. 1966 24 p ref
(ECOM-2761; AD-642100) CFSTI: HC$3.00/MF$0.65

This brief account of the meteorological conditions encountered before and after the onset of the summer monsoon in Arizona in 1966 will serve as background material for the research and

operational activities of the various groups taking part in the project. It discusses factors affecting seasonal variability on a local, state, and continental basis, and summarizes the daily forecast program carried out between 5 July and 2 August 1966. Author (TAB)

N67-19739# American Meteorological Society, Boston, Mass.
RELATIONSHIP BETWEEN THE RICHARDSON NUMBER AND ATMOSPHERIC TURBULENCE [K VOPROSU O SVIAZI CHISLA RICHARDSONA S ATMOSFERNOI TURBULENTNOST'IU]
L. G. Gruzinova and E. I. Sofiev Bedford, Mass., AFCRL, Oct. 1966 8 p refs Transl. into ENGLISH from Tr. Sredneazi. Nauchn.-Issled. Gidrometeorol. Inst. (Tashkent), no. 19(34), 1964 p 79–82
(Contract AF 19(628)-3880)
(T-R-613; TT-67-60156; AD-643358) CFSTI: HC $3.00/MF $0.65

The paper presents distributions of Richardson numbers in zones with and without turbulence, on the basis of gustsonde data. Analysis of the resulting distributions showed there is no unequivocal relation between the measured turbulence and the Richardson number. Author (TAB)

N67-19990*# College of William and Mary, Williamsburg, Va.
INVESTIGATION OF SPECTRAL PROPERTIES OF ULTRAVIOLET GRATINGS Semiannual Status Report, 1 Sep. 1966–28 Feb. 1967
Melvin A. Pittman 1 Mar. 1967 7 p
(Grant NGR-47-006-027)
(NASA-CR-82926; SASR-1) CFSTI: HC $3.00/MF $0.65 CSCL 20F

A summary report is given of investigation of the properties of uv gratings, original and replica, before and after exposure to simulated space environments. Effort devoted to measuring the efficiency and scattered light of plane gratings before and after exposure to electron bombardment in vacuum is described, and research in the following areas is described by phases: uv source stability, vacuum system, grating adaptor, grating protection, one meter monochromator, and preliminary tests of plane gratings. L.E.W.

N67-20018# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
SPECTRAL TRANSPARENCY AND MICROSTRUCTURE OF ARTIFICIAL FOG
V. Ye. Zuyev, V. Kabanov, B. Koshelev, S. D. Tvorogov, and S. D. Khmelevtsov 2 Sep. 1966 18 p refs Transl. into ENGLISH from Izv. Vyssh. Ucheb. Zaved., Fiz. (Tomsk), no. 2, 1964 p 90–97
(FTD-HT-66-396; TT-67-60239; AD-643900) CFSTI: HC $3.00/MF $0.65

This article describes the apparatus, measurement method and results of experimental studies of the microstructure and spectral transparency of artificial fog. It is demonstrated that the data obtained may be used applicably to natural liquid-droplet clouds and fog. TAB

N67-20313# Deutsche Versuchsanstalt fur Luft- und Raumfahrt, Munich (West Germany). Institut fuer Physik der Atmosphaere.
MEASUREMENTS OF WIND AND TEMPERATURE IN STRATOSPHERE AND MESOSPHERE BY METEOROLOGICAL SOUNDING ROCKETS (SARDINIA, AUTUMN 1963 AND SPRING 1964) [WIND- UND TEMPERATURMESSUNGEN IN DER STRATOSPHAERE UND MESOSPHAERE MIT HILFE METEOROLOGISCHER RAKETEN IN SARDINIEN IM HERBST 1963 UND IM FRUEHJAHR 1964]
Hans Gerhard Mueller, Walter Attmannspacher, and Martin Schurer Dec. 1966 85 p refs In GERMAN; ENGLISH Summary
(DLR-FB-66-80; DVL-592) CFSTI: HC $3.00/MF $0.65

Two periods of meteorological measurements of wind velocity, wind direction and free air temperature were made in upper stratosphere and lower mesosphere. Experiences with rockets, rocketsondes and radartracking equipment used are described. The results of the two periods of measurement are given in form of graphs and tables. For both periods the change of windvector with altitude and the time variation of wind are determined. The measurements in autumn were made after the wind regime in the upper circulation system had changed. During the spring period the change of wind direction from west in winter to east in summer could be confirmed; the results are discussed. Author

N67-20349# Texas A&M Univ., College Station. Dept. of Meteorology.
RESEARCH ON TROPICAL RAINFALL PATTERNS AND ASSOCIATED MESOSCALE SYSTEMS Final Report, May 1962–Oct. 1966
Walter K. Henry, John F. Griffiths, L. Glen Cobb, and John S. Cornett Oct. 1966 162 p
(Contract DA-36-039-AMC-89202)
(ECOM-89202-F; REPT-11; AD-642861) CFSTI: HC $3.00/MF $0.65

Selected rainstorms in Nicaragua and Guatemala are studied as to size and movement. Some relationships of the synoptic and mesoscale activity are identified. A method of studying month to month percentage changes in rainfall is described which yields consistent and analyzable patterns for Central America. Each monthly map is shown. An analysis of the daily rainfall records for several stations was completed using power spectrum analysis. The average spectrum based on the spectrum estimate from each of the stations indicated spectral peaks near 3 1/2 and 5 1/2 day periods. The monthly totals of rainfall at all stations were compared using coherence. The general results showed that stations 20 to 30 miles distance had the poorest relationship, until distances of over 80 miles were reached. The long period rainfall series of the national observatories of Venezuela and Ecuador are used to determine rainfall similarities and differences between two locations which vary greatly in circumstances. A preliminary analysis of some West Indian stations having long periods of record indicates that pronounced skewness occurs in the distribution. This would render the assumption of normality suspect unless modifications are made. The rainfall series for Guayaquil, Ecuador, which began in 1915, is discussed with specific attention given to the revision of records which was made for the period 1915-1943. Finally, a set of revised monthly rainfall maps of Panama are included. Author (TAB)

21 NAVIGATION

Includes guidance; autopilots; star and planet tracking; inertial platforms; and air traffic control. For related information see also: 07 Communications.

N67-19576# Royal Aircraft Establishment, Farnborough (England).
A COMPUTER STUDY OF AUTOMATIC CONTROL ON THE I.L.S. GLIDE PATH
G. Musker and Marian Henman Feb. 1967 51 p refs
(RAE-TR-66057; AD-640807) CFSTI: HC $3.00/MF $0.65

A computer study is described of the effect on I.L.S. glide path performance of the addition of various damping terms to the glide path control law of a typical autopilot. The control laws used are analysed by a number of techniques and the results achieved by the different techniques are compared. It is shown that the performance can be improved by the addition of either a vertical velocity term coupled with an acceleration term, or a vertical velocity term coupled with a pitch rate term in the control law. Author (TAB)

N67-19960# Royal Aircraft Establishment, Farnborough (England).
DIGITAL SIMULATION STUDY OF AN IDEALISED MODEL OF A COMPUTER-CONTROLLED PROCEDURAL FREE-ROUTE SYSTEM FOR NORTH ATLANTIC AIR TRAFFIC
M. R. Abbott May 1966 32 p refs
(RAE-TR-66147)

This report describes a digital simulation of a simple version of an idealized computer-controlled procedural free-route air traffic system for the North Atlantic. Changes of both flight level and track can be applied in order to avoid violation of the separation standards between a new flight being routed and any earlier flight. The routing of east to west flights is considered during the peak period of the day. The data for the simulation is generated statistically from a small sample of real traffic data. The results show the dependence of the number of flights requiring deviations of various types, on the amount of traffic, the separation standards, and aircraft speed. The results obtained for the traffic planning capacity of the system can be summarized approximately by a dimensional argument. The simulation program could be more detailed and specific in many possible ways. What is presented is seen as an informative first step which includes the most essential features without introducing too many arbitrary assumptions of limited overall significance. Author

N67-19982*# Research Triangle Inst., Durham, N. C.
AN APPRAISAL FOR USE IN RELIABILITY ANALYSIS OF THE TEST AND DATA COLLECTION PROCEDURES IN THE MANUFACTURE OF AN INERTIAL GUIDANCE SYSTEM
W. S. Conner and W. S. Thompson Dec. 1963 66 p refs *Its* Working Paper 10
(Contract NASw-334)
(NASA-CR-82979; GU-88) CFSTI: HC $3.00/MF $0.65 CSCL 17G

A general description of the production test procedures studied for each element in the first gimbal stabilization loop is presented for the Centaur inertial guidance system. Sufficient data were available to identify the gyro as the major source of drift in the loop, and the gyro drift rate was designated as a drift attribute to be considered in detail. Another tentative source of element drift affecting platform drift was identified as the gimbal control amplifier null current. The break-away frictional torques of the torque motor and slip rings were another source of variation in the loop. The gimbal was cited as a possible source of variation through mass unbalance effects. Supplementary data are included on the six positions drift test designed to measure primarily the drift rates due to deterministic torques. The tree hour drift test for measuring the gyro drift rate due to random distrubing torques is discussed, and a mathematical model of the gyro drift rate is presented. S.P.

N67-20329# Royal Aircraft Establishment, Farnborough (England).
ASSESSMENT OF THE PERFORMANCE OF THE ELDO FIRST PROGRAM ATTITUDE REFERENCE UNIT IN AN INERTIAL ROLE
D. W. Albery Oct. 1966 56 p refs
(RAE-TR-66314) CFSTI: HC $3.00/MF $0.65

Presented are numerical results for velocity and position errors accrued by an imperfect inertial navigator, when the gyroscopes and accelerometers comprising the instrument are subjected to the acceleration history expected from a launch trajectory of the ELDO-A Satellite launch vehicle. The inertial navigator under consideration consists of the ELDO First Program Attitude Reference Unit modified for an inertial role by the addition of three accelerometers and associated electronic circuits. The sources of error considered are discussed briefly. Results are presented for the following three trajectories: a medium altitude (550 km) circle, a medium altitude (700 km) circle with two levels of thrust in the third stage, and a low altitude (200 km) circle with parking periods. Methods of error reduction are discussed. Author

22 NUCLEAR ENGINEERING

Includes nuclear reactors and nuclear heat sources used for propulsion and auxiliary power. For basic research see: 24 Physics, Atomic, Molecular, and Nuclear. For related information see also: 03 Auxiliary Systems; and 28 Propulsion Systems.

N67-19440# Oak Ridge National Lab., Tenn.
REACTOR INSTRUMENTATION AND CONTROLS
In its Instrumentation and Control Div. Ann. Progr. Rept., for Period Ending Sep. 1, 1965 Aug. 1966 p 125–126 refs (See N67-19423 09-14) CFSTI: HC $3.00/MF $0.65

For reactor safety purposes, technological advancements on reactor instrumentation and controls, and component development are briefly reported. A period safety module was designed and tested as part of the series of transistorized instrument modules for the Molten Salt Reactor Experiment. The purpose of the module is to measure reactor period and to produce a signal which can be used to trip a safety channel should the period become too short. Safety operation of the modules was entirely satisfactory. A safety system, a startup instrument covering ten decades, and a multiple-channel regulating system—all transistorized and employing modular construction—are described. This summary information also mentions a cladding-failure detector and a flux asymmetry detector. R.Ll.

N67-19442# Oak Ridge National Lab., Tenn.
THEORETICAL INVESTIGATIONS
In its Instrumentation and Control Div. Ann. Progr. Rept., for Period Ending Sep. 1, 1965 Aug. 1966 p 128–131 refs (See N67-19423 09-14) CFSTI: HC $3.00/MF $0.65

To study neutron density fluctuations induced by hydraulic noise in a power reactor, a compressible fluid model was devised. The fluid model was coupled to the reactor dynamics equations to provide theoretical transfer functions connecting the relevant coolant variables to the neutron density. A series of connecting equations are presented, together with specified linearized space-independent reactor kinetics equations, and certain delayed heating equations. Transfer functions relating time behavior at the inlet to the reactor are calculated numerically using a general, digital frequency-response program. Also included is some speculative theory on the interpretation of neutron noise experiments. R.Ll.

N67-19443# Oak Ridge National Lab., Tenn.
EXPERIMENTAL INVESTIGATIONS
In its Instrumentation and Control Div. Ann. Progr. Rept., for Period Ending Sep. 1, 1965 Aug. 1966 p 131–135 refs (See N67-19423 09-14) CFSTI: HC $3.00/MF $0.65

To determine its inherent stability characteristics, an extensive theoretical analysis was made of the kinetic behavior of the Molten Salt Reactor Experiment. Several digital computer codes were developed to implement the analysis, and most of these are considered sufficiently general to be useful in other stability analyses. General purpose codes were also written for determining pole configurations and the sensitivity of the frequency response to parameter variations from the coefficient matrix. Other tests were made to determine the power spectral density of the neutron-level fluctuations, the pressure-to-reactivity transfer function with entrained gas in the fuel salt, and the transient behavior associated with startup and coastdown of the fuel and coolant circulating pumps. Test results showed good agreement with the predicted behavior. R.Ll.

N67-19444# Oak Ridge National Lab., Tenn.
CONTROL AND INSTRUMENT SYSTEMS ENGINEERING
In its Instrumentation and Control Div. Ann. Progr. Rept., for Period Ending Sep. 1, 1965 Aug. 1966 p 135–139 refs (See N67-19423 09-14) CFSTI: HC $3.00/MF $0.65

Technical details on design, fabrication, installation, and checkout revisions and modifications of the Molten-Salt Reactor Experiment (MSRE) instrumentation and controls system are briefly outlined. During this period, the Low-Intensity Test Reactor (LITR) control and safety systems, including associated instrumentation, were completely rebuilt and upgraded. A gas-cooled nuclear power plant control system was examined and the problem of loose coupling between reactor power and steam temperature solved by including a tight flux-control loop to a rod controller used to regulate the steam temperature. Analog computer studies show that the control system was able to make the simulated plant smoothly follow both large changes of turbine load and small, rapid changes of turbine load (1% per second) while limiting the transient variations in steam conditions to acceptable values. In addition, the servo system of the High Flux Isotope Reactor (HFIR) was examined for stability and response during expected transients in power demand and coolant flow. R.Ll.

N67-19445# Oak Ridge National Lab., Tenn.
TRAINING AND METHODS
In its Instrumentation and Control Div. Ann. Progr. Rept., for Period Ending Sep. 1, 1965 Aug. 1966 p 139–141 (See N67-19423 09-14) CFSTI: HC $3.00/MF $0.65

The training of operators and supervisors of new reactors is briefly discussed. A reactor controls training simulator, coupled to the analog computer, constitutes a complete facility for such training. Operator trainees gained a general understanding and feel of reactor behavior prior to classroom instruction. The training sessions demonstrated the usefulness of the simulator as a training aid, and in addition, a few operating difficulties were uncovered. Also, two reactor-kinetics simulators were developed for training Molten-Salt Reactor /MSRE/ operators in nuclear startup and power level operating procedures. A training simulator was also prepared to give the Tennessee Valley Authority (TVA) operators experience with the operation and behavior of the Experimental Gas-Cooled Reactor (EGCR) before the actual startup of the plant. R.Ll.

N67-19446# Oak Ridge National Lab., Tenn.
IN-PILE IRRADIATION
In its Instrumentation and Control Div. Ann. Progr. Rept., for Period Ending Sep. 1, 1965 Aug. 1966 p 141–146 *ref* (See N67-19423 09-14) CFSTI: HC $3.00/MF $0.65

Consideration is given to facilities, installations, and support activities for in-pile irradiation experiments. A block diagram shows the control system of HN-21 pneumatic tube system. This system, developed to meet design criteria, employs relay logic, an electromechanical program timer to set the irradiation period, an electronic interval timer to measure the irradiation time, and solenoid valves to effect injection and ejection of the rabbits (sample capsules). A simplified flow sheet depicts the HB-5 facility instrumentation. At the Oak Ridge Research Reactor Capsule Test Facility, eight different capsules were irradiated for three reactor programs: Experimental Gas-Cooled Reactor (EGCR), advanced gas-cooled reactors (Thermal Advanced Reactor Gas-Cooled Exploiting Thorium), and space power plants. It is also reported that instrumentation at the Capsule Test Facility of the Low-Intensity Test Reactor (LITR) was changed to accommodate a wider variety of experiments. R.Ll.

N67-19447# Oak Ridge National Lab., Tenn.
MSRE PROJECT INSTRUMENTATION
In its Instrumentation and Control Div. Ann. Progr. Rept., for Period Ending Sep. 1, 1965 Aug. 1966 p 146–149 *ref* (See N67-19423 09-14) CFSTI: HC $3.00/MF $0.65

A concise discussion is presented on project instrumentation for digital control, and for the sampling and enriching systems of the Molten-Salt Reactor (MSRE). A schematic shows the sampler-enricher and control panels in place at the reactor site. The coolant-salt sampler operation is mentioned, and design progressed on the fuel-salt processing plant sampler. During this period, instrumentation and controls design for the surveillance-program controlled test rig was completed. The controlled test rig exposes metallurgical samples to conditions which, except for nuclear radiation, approximate the conditions experienced by similar samples installed in the MSRE core. Also reported is the measurement of the concentration of undissolved helium in circulating molten salt. R.Ll.

N67-19448# Oak Ridge National Lab., Tenn.
MISCELLANEOUS
In its Instrumentation and Control Div. Ann. Progr. Rept., for Period Ending Sep. 1, 1965 Aug. 1966 p 150 *refs* (See N67-19423 09-14) CFSTI: HC $3.00/MF $0.65

Abstracted information is presented on current practices with respect to the provision and use of secondary shutdown systems of several power reactors in the United States. Brief summary data are included on the practices in the power reactors of the United Kingdom and France. It is pointed out that although most of the reactor facilities examined are equipped with alternate shutdown devices, designated secondary shutdown systems, there is rather a large variation in the independence and performance of the actual systems employed. R.Ll.

N67-19449# Oak Ridge National Lab., Tenn.
INSTRUMENTATION FOR REACTOR DIVISION TEST LOOPS
In its Instrumentation and Control Div. Ann. Progr. Rept., for Period Ending Sep. 1, 1965 Aug. 1966 p 151–158 refs (See N67-19423 09-14) CFSTI: HC $3.00/MF $0.65

Scientific instrumentation for various reactor test loops was developed during this period. The liquid-metal jet-pump test loop is reported being designed to obtain data on the characteristics of a jet pump operating with liquid potassium at temperatures from 400° to 1540°F. To obtain data on a high-temperature Rankine cycle using potassium, instrumentation was provided for the Small Potassium Loop No. 1. For one of several out-of-pile tests necessary for the development of the Medium-Power Reactor Experiment (MPRE), an instrumentation system for a small, boiling-potassium loop was designed. Also reported is the installation of instruments to obtain operating data from the Intermediate Potassium System. This system uses a high-temperature Rankine cycle, and potassium is the working fluid. R.Ll.

N67-19512# Oak Ridge National Lab., Tenn.
PROCESSING OF POWER-REACTOR FUELS
B. C. Finney and C. D. Watson *In its* Unit Operations Sect. Sep. 1966 p 21 (See N67-19510 09-06) CFSTI: HC $3.00/MF $0.65

The development and evaluation of a batch shear-leach process for recovering fissile and fertile materials from spent power-reactor fuel assemblies were continued. The packing density and void fraction of sheared and leached sections of 0.5-in.×1-in.-long tubing was determined to be 1.2 kg/l and 85%, respectively. Typically, for each metric ton uranium processed, about 100 gal of empty metallic hulls will be produced for a fuel of the type used in the nuclear merchant ship Savannah. NSA

N67-19594*# Oak Ridge National Lab., Tenn. Metals and Ceramics Div.
COMPATIBILITY STUDIES OF MATERIALS IN SNAP-8 PRIMARY SYSTEM
B. Fleischer, A. Taboada, W. R. Huntley, H. W. Savage, and R. E. MacPherson *In* AEC AEC–NASA Liquid Metals Inform. Meeting 23 Apr. 1965 p 119–129 refs (See N67-19581 09-17) CFSTI: HC $3.00/MF $0.65

Summary data are presented to show the effects of hot-leg temperature, hydrogen, oxygen content, and time on the corrosion of materials in the SNAP-8 forced-flow NaK corrosion loops. The findings indicate: (1) Increasing the hot-leg temperature from 1300° to 1400° F significantly affects Hastelloy N corrosion, only slightly affects type 347 stainless steel corrosion. (2) Hydrogen does not deleteriously affect corrosion of any materials. (3) Increasing oxygen from <30 ppm to approximately 80 ppm increases the corrosion rate of the iron-base alloys, has little effect on the nickel-base alloy. (4) The effect of time is approximately linear for Hastelloy N, but somewhat less than linear for type 347 stainless steel. In analyzing the corrosion mass transfer products in the high oxygen loops, a nonmagnetic complex oxide, identified as sodium–chromite, was found. Extensive carbon migration was also noted in both the 1300° and 1400°F loops. M.G.J.

N67-19595*# Aerojet-General Nucleonics, San Ramon, Calif.
STATUS OF SNAP 8 NaK CORROSION PROGRAM AT AGN
B. E. Farwell and M. F. Parkman *In* AEC AEC–NASA Liquid Metals Inform. Meeting 23 Apr. 1965 p 121–129 refs (See N67-19581 09-17) CFSTI: HC$3.00/MF$0.65

The corrosion and mass transfer patterns created by the NaK loop are being evaluated. The system design and operating history are outlined, and the temperature profile through the boiler is depicted. It is shown that as the run progressed, the NaK profile steepened so that the maximum 1300°F temperature was reached at about the 30 ft mark after 2000 hours; it remained fairly constant until final shutdown after some 4400 hours. Following sigma phase embirttlement of the NaK heater, failure was attributed to thermal shock caused by the cold NaK entering the heater from the purification system. No detrimental effects of any kind were noted in the heat rejection loop. M.G.J.

N67-19597*# Los Alamos Scientific Lab., N. Mex.
MASS TRANSFER OF Ta IN MOLTEN Pu–Co–Ce FUELS—THE LINEAR DIFFUSION EXPERIMENT
J. C. Biery and C. R. Cushing *In* AEC AEC–NASA Liquid Metals Inform. Meeting 23 Apr. 1965 p 138–142 (See N67-19581 09-17) CFSTI: HC$3.00/MF$0.65

Details are given on a diffusion experiment which was designed to give quantitative measures of Ta mass transfer and mass transfer parameters in a linear system under isothermal and temperature gradient conditions. A gamma active tantalum tab is placed in the bottom of a 6 in. long × 0.388 in. diameter capsule which is then filled with from 4 to 4-1/2 in. of Pu–Co–Ce alloy. The capsule is heated in a small vertical tube furnace at temperatures from 600° to 800°C; the furnace can be held to within ±2°C of the desired temperature for long time periods. The dissolution and transfer of the gamma active tantalum from the tab is measured by scanning the capsule with a well collimated gamma detector. Ten minute counts are taken at 0.05 in. intervals up the capsule. The active tantalum in a given section is determined by integrating the area between the smoothed count curve and an estimated coherent scattering curve. The area is weighted according to the decay of the active tantalum. Summarized data obtained from three runs are presented. M.G.J.

N67-19621# Atomic Energy Commission, Washington, D. C.
HIGH TEMPERATURE THERMOMETRY
Mar. 1966 361 p refs Presented at the AEC Seminar, Washington, D. C., 24–26 Feb. 1965
(NASH-1067) CFSTI: HC$3.00/MF$0.65

In the conference papers presented on high temperature thermometry, interest was focused on fabrication technology, materials compatibility, service experience, research studies, and advanced techniques. For individual titles see N67-19622–N67-19647.

N67-19622# Atomic Energy Commission, Washington, D. C.
SUMMARY OF EXPERIENCE WITH HIGH-TEMPERATURE THERMOCOUPLES USED IN THE ORNL–GCR PROGRAM FUEL IRRADIATION EXPERIMENTS
N. H. Briggs, E. L. Long, Jr., and F. R. McQuilkin *In its* High Temp. Thermometry Mar. 1966 22 p refs (See N67-19621 09-22) CFSTI: HC$3.00/MF$0.65

Summarized are experiences with 44 high temperature thermocouples used in several irradiation tests of encapsulated fuel materials for the Experimental Gas Cooled Reactor (EGCR) and advanced Gas Cooled Reactor (GCR) programs. Presented are data on the design of thermocouple assemblies and their compatibility with several types of fuel materials. Thermocouple design focused on protecting thermocouple wires from direct contact with the fuel materials and providing an inert gas (usually helium) environment independent of the fuel gas environment. The 44 thermocouples were classified into six types with appropriate subtypes. The thermocouple wires were $Pt/Pt_{90}Rh_{10}$, W/Re, or $W_{95}Re_5/W_{74}Re_{26}$. Thermocouple types 1, 2, and 3 have bare wires beaded with BeO insulation and are inserted into protective wells (bare-wire thermocouples), while the types 4, 5, and 6 are tantalum sheathed thermocouples inserted into wells. Types 3 and 6 have sacrificial sleeves that are intended to react with the surrounding fuel materials. Fuels tested included UO_2 bushings; UO_2 dispersions in BeO; vibratorily compacted ThO_2–UO_2; pyrolytic carbon coated particles of UC_2 or (U, Th)C_2, either loose or in graphite matrices of several geometries; and BeO–graphite materials for compatibility studies. Tabulated are performance and thermal neutron exposure data for each of the types of thermocouples tested. S.C.W.

N67-19623# Atomic Energy Commission, Washington, D. C.
IN-PILE PERFORMANCE OF HIGH-TEMPERATURE THERMOCOUPLES
R. M. Carroll and P. E. Reagan *In its* High Temp. Thermometry Mar. 1966 9 p refs (See N67-19621 09-22) CFSTI: HC $3.00/MF$0.65

The in-pile performance of Pt/Pt-10% Rh (Pt–Rh) and W-5% Re/W-26% Re (W–Re) thermocouples exposed to long term irradiation at high temperatures was evaluated. Also evaluated was the influence of carbon, hydrogen, oxygen, and insulating materials on the life and performance of the thermocouples. Two general categories of fuels were tested: thin plates of uranium dioxide and spherical uranium carbide coated with graphite. Platinum/Pt-10% Rh and W-5% Re/W-26% Re thermocouples were not significantly affected by neutron irradiation flux up to 1×10^{14} neutrons cm^{-2} sec^{-1} or a dose of 3.6×10^{20} neutrons/cm^2 thermal or 2.8×10^{20} neutrons/cm^2 fast. Oxygen and hydrogen caused failures characterized by abrupt shifts of emf in W–Re and Pt–Rh thermocouples, respectively. Tungsten–rhenium thermocouples performed well in an atmosphere containing some hydrogen. Platinum–rhenium thermocouples should not be used for temperatures above 1100°C, because the platinum reacts with materials in the capsule (UO_2, graphite, Inconel). Thermocouple insulators of high purity, high fired Al_2O_3 will withstand all conditions for temperatures up to 1400°C if carburization barriers are used. Direct contact with graphite will cause both Pt–Rh and W–Re thermocouples to fail; however, rhenium appears to be a good barrier material. A W-5% Re/W-26% Re thermocouple, insulated with BeO and sheathed in either tungsten or rhenium, with an outside diameter of not more than 0.060 in. is suggested for use at <1400°C. S.C.W.

N67-19633# Atomic Energy Commission, Washington, D. C.
DYNAMIC GAS THERMOMETRY
E. W. Hagen *In its* High Temp. Thermometry Mar. 1966 8 p (See N67-19621 09-22) CFSTI: HC $3.00/MF$0.65

Nozzles made from selected materials were studied to determine their long term stability and accuracy in the ORNL Experimental Gas Cooled Reactor (EGCR) and the feasibility of

using very small nozzles (0.010 in throat) for other high temperature measuring problems. Focused upon were the effects of simulated EGCR gas conditions on flow calibration. Extended time tests on nozzles fabricated from types 304 and 321 stainless steels and from Inconel were conducted. A shift in the value of the flow coefficient was noted after 150 hr of high temperature operation. Three other nozzles, two of which were made from type 304 stainless steel, were tested for flow coefficient stability. As expected, the smallest nozzle showed the largest percentage change in flow coefficient, and the largest nozzle showed the smallest change. The applicability of the relatively inexpensive cemented carbides to pneumatic temperature measuring systems was also studied. Development of a satisfactory mounting technique remains the principal problem. The development of a temperature measuring system utilizing miniature nozzles made from type 304 stainless steel which successfully measured furnace temperatures up to 1600°F, is reported. A practical lower limit of 0.015 in was found for nozzle throat diameters during the stability testing of nozzle flow coefficients. Results of a life test on a one-third scale nozzle which was conducted in an environment simulating reactor operating conditions are discussed. The requirements for studying the stability of EGCR–PTM nozzles were determined and a closed-loop test facility was constructed. S.C.W.

N67-19634# Argonne National Lab., Ill.
REFRACTORY OXIDE INSULATED THERMOCOUPLE ANALYSIS AND DESIGN
Glenn F. Popper and Togan Z. Zaren *In* AEC High Temp. Thermometry Mar. 1966 26 p refs (See N67-19621 09-22) CFSTI: HC $3.00/MF $0.65

Research focusing on the development of refractory oxide insulated thermocouples for the Fast Reactor Test (FARET) program which can measure fuel pin temperatures as high as 2760°C, is reported. Presented are results of theoretical, experimental, and prototype FARET thermocouple calculations of the hot zone errors of high temperature thermocouples; and results of compatibility studies of materials considered potentially useful for the thermocouple sheath, electrical insulation, and wire. The feasibility of using a capacitance discharge welding technique for attaching the reference design tungsten–rhenium alloy thermocouple wire to base metal pins and making thermocouple hot junctions was also studied. Results showed that this technique can be successfully applied to making junctions between the reference design thermocouple wire and extension lead wire or the connector pins. S.C.W.

N67-19638# General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operations.
THERMOCOUPLE RESEARCH AT GE-NMPO
William C. Kuhlman 10 Feb. 1965 *In* AEC High Temp. Thermometry Mar. 1966 29 p ref (See N67-19621 09-22) CFSTI: HC $3.00/MF $0.65

Research focusing on the development of reliable thermocouple systems for continuous monitoring of temperatures inside nuclear reactors is reported. The established W/W –25Re thermocouple system was employed as a standard for determining the thermoelectric properties of potentially useful materials. Presented are data on instrumentation of the experimental refractory metal clad fuel elements, materials specifications, reactor and simulated reactor tests of W/W –25Re thermocouples, thermocouple error due to thermal breakdown of insulation, transmutation effects in the W/W –25Re thermocouple, thermocouple alloy development, and thermoelectric characteristics of metals with low thermal neutron cross section. S.C.W.

N67-19639# General Dynamics Corp., San Diego, Calif. John Jay Hopkins Lab. for Pure and Applied Science.
HIGH TEMPERATURE THERMOMETRY AT GENERAL ATOMIC
F. D. Carpenter and J. O. Barner *In* AEC High Temp. Thermometry Mar. 1966 22 p (See N67-19621 09-22) CFSTI: HC $3.00/MF $0.65

Research designed to measure or improve thermometry reliability in a reactor system or environment is discussed. Summarized are studies focusing on: the optical measurement of temperatures in a furnace apparatus within the TRIGA reactor core; the utilization of tungsten-5% rhenium/tungsten-26% rhenium thermocouples and the newly developed acoustical thermometers to monitor temperatures in the high temperature gas cooled reactor (GCR); and the measurement of temperatures in irradiation test capsules with fuel specimen operating above 1000°C. Author

N67-19640# Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.
PHILLIPS' DEVELOPMENTS IN HIGH TEMPERATURE THERMOMETRY AT THE NRTS
R. H. Meservey *In* AEC High Temp. Thermometry Mar. 1966 6 p (See N67-19621 09-22) CFSTI: HC $3.00/MF $0.65

A brief summary of techniques which have been used and which are being developed in high temperature thermometry is presented. Techniques which have been used in determining fuel plate temperatures include "separated-meat" fuel plates. This method allows the temperature at the center of the fuel to be measured while avoiding some of the heat transfer, nuclear, and safety problems encountered when a thermocouple is inserted through the cladding and into the fuel. Another method which has been used is one in which a bulk cladding temperature measurement was made using an instrumented fuel plate which was electrically insulated from the rest of the core and a constant current passed through it. Voltage taps placed at intervals along the plate can be used to determine the resistance change in a given interval and hence, the bulk temperature in that interval. Research in progress includes the construction of fuel cells in which tungsten/tungsten–26% rhenium thermocouples, in conjunction with a number of small samples of elements having different melting temperatures, are used as temperature sensors in reactor destructive tests. Another approach under development is the use of fiber optics to transmit infrared radiation from a fuel pin to a detector located outside the core. Also summarized are high temperature thermometry requirements of the LOFT program (Loss of Fluid Tests), Power Burst Facility (PBF), and Special Power Excursion Reactor Tests (SPERT) project. S.C.W.

N67-19642# Bettis Atomic Power Lab., Pittsburgh, Pa.
IN-PILE REFRACTORY THERMOCOUPLE EXPERIENCE AT WESTINGHOUSE ATOMIC POWER
J. A. Christensen and H. M. Ferrari *In* AEC High Temp. Thermometry Mar. 1966 14 p refs (See N67-19621 09-22) CFSTI: HC $3.00/MF $0.65
(Contracts AT(30-1)-2289; AT(30-1)-3269)

Presented are results of in-pile experiments designed to evaluate refractory thermocouples and to determine their applicability in measuring temperature distributions in high rated ceramic fuels during irradiation. Focused upon were W/W-26% Re thermocouples. Experiments designed to obtain supplementary fuel temperature data and to explore the performance of refractory thermocouples in-pile; and tests designed to measure fuel temperature distribution and its variation with changing UO_2 grain structure and stoichiometry are reported. Results of these experiments indicated that: (1) the conventional, tantalum sheathed, BeO insulated, W/W-26% Re thermocouple is usable in-pile for measuring UO_2 temperatures to about 1900°C for approximately 50 hours; (2) a tungsten–rhenium alloy sheath extends the maximum use temperature of BeO insulated, W/W-26% Re thermocouples to approximately 2300°C for time periods of about 25 hours; and (3) relatively subtle environmental changes can drastically affect thermocouple lifetimes. S.C.W.

N67-19643# Los Alamos Scientific Lab., N. Mex.
THERMOCOUPLE DEVELOPMENT FOR PROJECT ROVER
E. A. Brown, B. G. Goodier, J. E. Perry, Jr., R. L. Petty, W. R. Prince et al *In* AEC High Temp. Thermometry Mar. 1966 33 p refs (See N67-19621 09-22) CFSTI: HC$3.00/MF$0.65

Research focusing on the development of W/W 26 Re thermocouples, insulated by BeO and encased in Mo or Ta sheaths, for use in the control and diagnostic measurement of the thermal behavior of cores in the Kiwi and Nerva reactors of Project Rover, is reported. Studies related to the two major problems of shunting and sheath integrity are described. Because of uncertainties in BeO resistivity and wire-to-insulator contact, digital calculations were used to determine the dependence of shunt effects on various parameters (resistance and thermal emf). Shunt effect calculations qualitatively confirmed the locally measured shunt losses, and calculations of the distributed Peltier effect agreed qualitatively with hot zone measurements. Several sheath materials were tried in an attempt to find one which would survive in the reactor environment up to temperatures of 5000°R. Evaluated were molybdenum, 74% tungsten 26% rhenium, 75% tungsten 25% molybdenum, tantalum, tantalum with 0.005" vapor deposited W outer coat, and 90% tantalum 10% tungsten. Despite the uncertainty about hydride formation, Mo, Ta, and Ta 10 W were chosen for the second generation core thermocouples. Seventy-five percent tungsten 25% Mo performed well on a limited number of tests. Seventy four percent tungsten 26% Re with a W outer coat is under consideration. Proposed design concepts for standard and advanced thermocouples are discussed. Also discussed are problems of radiation effects and differential thermal expansion. S.C.W.

N67-19644 Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.
STATUS OF HIGH TEMPERATURE THERMOMETRY FOR THE NERVA REACTOR
A. W. Hoppe and P. J. Levine *In* AEC High Temp. Thermometry Mar. 1966 45 p refs (See N67-19621 09-22) CFSTI: HC $3.00

The design of thermocouples to measure temperatures to 5000°R (2500°C) in carbon and hydrogen environments involves complicated selections of materials as well as optimum sizes of components. In addition to carburization which embrittles the sheaths, the melting points of the refractory metals are substantially reduced by the presence of carbon and possible formations of metal–carbon eutectic compositions. The hydrogen severely embrittles tantalum, and in addition, has been observed to affect the thermal EMF output of the couples causing increased errors in the high temperature measurements. Chemical and physical compatibility of the materials of construction are discussed; particularly, the combination of refractory metals and the oxide insulators. Besides basic materials considerations, programs for optimizing wire sizes and insulator dimensions have been developed. Tests on thermocouple assemblies point out the need for more fundamental testing to determine the optimum material combinations and specific environmental limits for a functional thermocouple. Author

N67-19647 Aerojet-General Corp., Sacramento, Calif. Component Development Div.
REON HOT GAS THERMOMETRY
W. P. Gilles, T. F. McGrath, and R. G. Hoff *In* AEC High Temp. Thermometry Mar. 1966 23 p refs (See N67-19621 09-22) CFSTI: HC$3.00

Development efforts in hot gas thermometry which are the result of the requirement to control reactor power during flight by measuring the temperature of the hot hydrogen gas exiting exiting from the NERVA reactor and passing through the nozzle; are reported. Thermocouples of the tungsten–rhenium type were selected as being the most practical. Environmental conditions to which the finished thermocouple is subjected during a NERVA test, material considerations, and proposed coaxial and two wire sheathed design concepts, are discussed. Also included are data on thermocouple calibration and error analysis; adiabatic gas and neutron absorption effects; probe insulator leakage, and extension lead insulation leakage. S.C.W.

N67-19774# Naval Radiological Defense Lab., San Francisco, Calif.
BETA DOSE RATES FROM NEUTRON-IRRADIATED URANIUM-235 CARBIDE PARTICLES
James F. Pestaner, Don A. Kubose, and William R. Balkwell 30 Jun. 1966 29 p refs
(Contract AT(49-2)-2505)
(USNRDL-TR-1082; AD-643651) CFSTI: HC$3.00/MF$0.65

Small highly radioactive particles could be injected into the biosphere from the re-entry and burnup of a nuclear propulsion reactor. This would constitute a potential radiological hazard to man. The work reported is the experimental measurement of beta dose rates from fission products contained in pyrolytic-carbon-coated uranium-235 carbide beads of core diameter 90, 120 and 260 microns. The dose was measured in an extrapolation chamber using tissue equivalent electrodes. The beta dose from the irradiated particles delivered to a segment of tissue can be calculated using a rate law derived from the experimental values. TAB

N67-19782# Naval Radiological Defense Lab., San Francisco, Calif.
BETA SPECTRA. IV: DEGRADED SPECTRA FROM A FINITE SPHERICAL SOURCE
Ora L. Hogan 10 Oct. 1966 32 p refs
(Contract AT(49-5)-2505(2))
(USNRDL-TR-1098; AD-644649) CFSTI: HC$3.00/MF$0.65

A FORTRAN II program has been written to compute the degradation undergone by a theoretical beta spectrum in emerging from a spherical particle of high density, high Z material. Inputs to the program are the point source (or undegraded) beta spectrum and the coefficients of a degradation function. Outputs from the program are the degraded spectrum and its expected and median energies. Data are presented for degradation of beta spectra originating within uranium carbide particles. Author (TAB)

N67-19848# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
CERTAIN PERSPECTIVES FOR THE USE OF THE PULSE METHOD OF DETERMINING THE ELASTIC CONSTANTS
L. M. Mukhin 27 Sep. 1966 8 p refs Transl. into ENGLISH from Primenenie Ul'traakustiki k Issled. Veshchestva (Moscow), no. 18, 1963 p 249–252
(FTD-HT-66-406; TT-67-60240; AD-643902) CFSTI: HC $3.00/MF$0.65

The application of the pulse method of determining the elastic constants to conditions when the investigated sample is in the active zone of the apparatus makes it possible to observe the kinetics of the effect of radiation on different material. The pulse method has significant advantages over resonance methods that use standing waves in samples: (1) The possibility of accurate temperature control on the working part of the sample through thermocouples. (2) Simultaneous determination of all the elastic constants on the same sample. (3) The possibility of removing the transducers from the active zone of the apparatus. The accuracy of this method can be very high, since it basically depends upon the accuracy of determining velocity. An experiment was conducted on graphite and copper samples. During the experiment certain changes were observed in the elastic properties of samples under the effect of radiation. Thus, the possibility of investigating the kinetics of the effect of irradiation on the elastic properties of materials with the aid of the pulse method was shown. TAB

N67-19854# Oak Ridge National Lab., Tenn.
PARALLEL-PLATE MULTISECTION IONIZATION CHAMBERS FOR HIGH-PERFORMANCE REACTORS
D. P. Roux Apr. 1966 44 p refs
(Contract W-7405-ENG-26)
(ORNL-3929) CFSTI: HC $3.00/MF $0.65

A model of parallel-plate multisection ionization chambers was developed for reactor control applications in high-performance reactors. The arrangement of the chamber allows the combination of different active sections in a single reactor penetration. Each active section is comprised of parallel-plate electrodes, each 1.8 in. in diameter and 0.005 in. thick. The electrodes are coated with ^{10}B for use as neutron-sensitive chambers, with ^{235}U for use as fission chambers, or left uncoated for use as gamma-sensitive chambers. An electrode configuration is used to achieve an electrically adjustable gamma compensation. This compensation technique has an advantage over other methods in that both the neutron- and gamma-section currents are well saturated at all polarizing voltages ordinarily used, and thus, electrical compensation is not obtained at the expense of saturation. Experimental results show the insensitivity of the gamma compensation to wide variations in intensity, energy, and geometry of the gamma background. Author

N67-19877*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
FLUID SYSTEMS DESIGN CONCEPT FOR A LARGE GAS-COOLED FISSION-ELECTRIC CELL REACTOR SPACE POWER PLANT
D. J. Mokski 1 Feb. 1967 49 p refs
(Contract NAS7-100)
(NASA-CR-82939; JPL-TM-33-283) CFSTI: HC $3.00/MF $0.65
CSCL 18I

The possibility of using a gas to transport waste heat from a large fission-electric cell reactor directly to a radiator is examined in order to obtain an estimate of: 1) the pumping power that would be required for such a system, 2) the size and weight of the reactor, radiator and other major components, and 3) temperature distributions in the core and other parts of the system. Also, a separate coolant circuit is assumed for removing heat energy from this portion of the core and converting it to electrical power for pumping and auxiliary power by means of a Rankine cycle. The sizes and weights of the major components of the auxiliary power system are also estimated. An overall specific weight of about 6.9 to 13.0 lb/kwe, not including shields, is obtained depending on the conversion efficiency: the higher weight corresponds to 5% conversion efficiency; the lower, to 10%. As might be expected, the radiator is found to be the largest and heaviest single component. However, the advantage in being able to radiate at a higher temperature is found to result in a potential reduction in radiator area of from 50 to 80% (depending on efficiency) as compared with that required for a comparable plant operating on a thermodynamic power-conversion cycle. Author

N67-20146# General Dynamics/Pomona, Calif. Engineering Dept.
NUCLEAR CLOUD SAMPLING SYSTEM
Robert L. Swetnam [1966] 25 p Prepared for Lawrence Radiation Lab., Livermore, Calif.
(Contract W-7405-ENG-48)
(UCRL-13215) CFSTI: HC $3.00/MF $0.65

A series of wind tunnel tests and related analytical studies were performed to establish the aerodynamic configuration of a vehicle for obtaining a debris sample from a cloud formed by a nuclear explosion. The vehicle configuration resulting from the program will obtain an isokinetic particulate sample from 40,000 to 90,000 feet altitude with growth capability to over 100,000 feet with only a filter change. A computer program capable of establishing design parameters for a gas sampling system was prepared. The application of the conical shock diffuser to the air sampling mission is believed to be unique to the state-of-the-art. NSA

N67-20149# Commissariat a l'Energie Atomique, Chusclan (France). Centre de Production de Plutonium de Marcoule.
THE HEALTH PHYSICS OF INSTALLATIONS FOR UNCANNING IRRADIATED FUELS OR FOR HANDLING RADIO-ELEMENTS AT MARCOULE [LA RADIOPROTECTION DES INSTALLATIONS DE DEGAINAGE DES COMBUSTIBLES IRRADIES ET DES RADIOELEMENTS A MARCOULE]
Jean Chassany, Pierre Guillermin, and Pierre Mallet Aug. 1966 78 p refs In FRENCH
(CEA-R-3019)

Radiation protection practices for handling reactor fuel elements are described. Elements of considerable specific radioactivity are handled under water. A study was made of water filtration and of ventilation in the building. The installations are divided up into zones depending on the radioactive risks, and the radiation level atmospheric contamination are the object of a systematic control at various points. A description is given of all aspects of health physics which have been encountered during six years: storage, transfer of radioactive material, uncanning, rolling, waste disposal, specialized operations, installations in operation and at rest, and transport. In spite of the gradual increase in the activity of these installations, the total doses received by the personnel have hardly altered and the number of cases of physical contamination has diminished. Author (NSA)

N67-20151# Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.
SAXTON PLUTONIUM PROJECT Quarterly Progress Letter, Period Ending 30 Sep. 1966
N. R. Nelson Oct. 1966 15 p
(Contract AT(30-1)-3385)
(EURAEC-1713) CFSTI: HC $3.00/MF $0.65

A program is being conducted to operate the Pu fuel for at least one equivalent full power year in the Saxton reactor, to analyze the performance of the Pu portion of Core II, and to examine irradiated fuel samples. Measurements made during the nuclear analysis of operating performance are reported. NSA

N67-20156# Atomic Energy of Canada Ltd., Chalk River (Ontario).
STRESS REORIENTATION OF HYDRIDES IN COLD-WORKED ZIRCONIUM-2.5 PERCENT NIOBIUM PRESSURE TUBES
G. W. Parry Aug. 1966 22 p refs
(AECL-2624) Available from Atomic Energy of Canada, Ltd., Chalk River: $1.00

The susceptibility of cold drawn Zr-2.5% Nb pressure tubes to reorientation of hydride precipitates during cooling under an applied stress was investigated. It is concluded that little orientstion occurs at stresses up to 35,000 psi, and when it occurs its effect on tensile properties is small. The tests tend to confirm the conclusions of previous investigators, that a high concentration of basal poles parallel to the applied stress is necessary for reorientation of the hydrides. Author (NSA)

N67-20160# General Dynamics Corp., San Diego, Calif. John Jay Hopkins Lab. for Pure and Applied Physics.
TIME-OF-FLIGHT MEASUREMENTS OF NEUTRON SPECTRA IN U-235 AND TUNGSTEN
A. E. Profio, J. C. Young, K. L. Crosbie, R. Hackney, H. M. Antunez et al 22 Sep. 1966 31 p refs Presented at Intern. Conf. on Fast Critical Expt. and their Anal., Argonne, Ill., 10–13 Oct. 1966
(Contract AT(04-3)-167)
(GA-7427; CONF-661019-2) CFSTI: HC $3.00/MF $0.65

The pulsed-source, time-of-flight method was used to measure neutron angular flux spectra to 15 MeV from a spherical ^{235}U metal critical assembly and spheres of tungsten. The object of the ^{235}U experiment was to test calculational methods for fast reactor spectra and the model for neutron inelastic scattering. The

tungsten spectra were measured at 300°K and 800°K as part of a current program to measure the effect of Doppler broadening on spectra. The principal features of the experimental technique are discussed, particularly time resolution, beam extraction, and detectors. The ^{235}U sphere measurements are presented and are compared with GAPLSN calculations. The spectrum is very close to that in a critical reactor, but there is a discrepancy between theory and experiment. The tungsten results show a clear difference between hot and cold, even to high energies. The difference can not be explained by the density change, and it is apparently the result of Doppler broadening scattering resonances. Calculations do not take this into account. Author (NSA)

N67-20172*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
FISSION-ELECTRIC CELL IRRADIATION
Walter F. Krieve 1 Mar. 1967 64 p refs
(Contract NAS7-100)
(NASA-CR-82876; JPL-TR-32-970) CFSTI: HC $3.00/MF $0.65 CSCL 18E

A series of capsule reactor irradiation experiments was performed to study the component behavior of fission electric cell devices under relatively high radiation intensity and with sufficient fuel burnup to establish operational trends. A detailed account of these experiments includes complete descriptions of the designs of the various fission electric cell capsules, discussions of some of the specialized fabrication techniques, and a description of the experiments themselves. The experiments were concerned with electrical characteristics of the cells and with the materials problems associated with extended irradiation periods. In addition to the in-pile measurements of cell performance (as well as calibration runs in intense gamma fluxes), the experiments included extensive post-irradiation, microscopic, and radiochemical analyses. Author

N67-20176# Virginia Univ., Charlottesville.
ATTENUATION OF NITROGEN-CAPTURE GAMMA RAYS IN CONCRETE
W. Reed Johnson Nov. 1966 59 p refs
(Contract DA-AMC-18-035-75(A))
(NDL-TR-82; AD-643754) CFSTI: HC $3.00/MF $0.65

Shielding experiments were performed to measure the attenuation by concrete slabs of nitrogen-capture gamma radiation. A collimated capture gamma-ray beam was produced by placing a Be3N2 target in the reactor end of a tangential beam hole. A 2-inch diameter beam with an average intensity of approximately 43 mR/h was allowed to impinge at the center of an ordinary concrete-slab shield; this shield was approximately 4-1/2 feet on a side and ranged from 4 to 24 inches thick. The slabs of the shield were rotated to allow measurements at beam angles of incidence of 90, 60, and 45 degrees. The gamma-ray exposure was integrated in a plane behind and parallel to the shield for each shield thickness and angle of incidence. The integrated exposure was determined by summing individual measurements made in a regular pattern in the plane behind the shield. Author (TAB)

N67-20206# General Dynamics Corp., San Diego, Calif. General Atomic Div.
ADVANCES IN FUEL ELEMENT DESIGN AND MATERIALS
R. F. Turner and W. V. Goeddel 17 Jun. 1966 20 p refs Presented at 12th Ann. Natl. Meeting of the Am. Nucl. Soc. Denver, 20–23 Jun. 1966
(Contract AT(04-3)-633)
(GA-7183; CONF-660606-54) CFSTI: HC $3.00/MF $0.65

Development of an improved HTGR fuel element of simplified construction which appears capable of high performance at high burnups for long periods of time is discussed. The element utilizes beds of coated fuel particles packaged in holes drilled in a hexagonal shaped graphite block. The development of this element was made possible to a large extent by significant advances in coated particle technology. BISO-type coated particles were irradiated to approximately end-of-life burnups in instrumented capsules showing excellent integrity and a high retentivity of fission products. These advances offer possibilities of low fuel costs which result in low total power costs in a system having high thermal efficiency. Author (NSA)

N67-20212# Kernsforschungsanlage, Juelich (West Germany). Institut fuer Reaktorentwicklung.
A SIMPLE ARRANGEMENT FOR THE ESTABLISHMENT OF THE FORM CHANGES OF ELECTRICALLY CONDUCTING SPHERES [EINE EINFACHE ANORDNUNG ZUR FESTSTELLUNG VON FORMAEN DERUNGEN ELEKTRISCH LEITENDER KUGELN]
R. Hecker Feb. 1966 21 p refs In GERMAN
(JUL-357-RG)

An automatic device for the determination and measurement of the form changes of electrically conducting spheres exposed to reactor irradiation is described. The damage detection is based on the relation between the denting of the surface and the extent of the damage and on the orientation of the damage site to the coil axis. NSA

N67-20218# Atomic Energy of Canada, Ltd., Chalk River (Ontario).
THE EXAMINATION OF DEFECTED NPD FUEL BUNDLE 0982
R. T. Popple and G. H. Chalder Aug. 1966 16 p refs
(AECL-2608; EXP-NPD-205; Rept.-611-2.093441-6) Available from Atomic Energy of Canada, Ltd., Chalk River: $0.50

An NPD fuel bundle removed from the reactor in a defected condition was examined. The defect was found to be in the form of an asymmetric gouge removed from the end cap-sheath weld zone of one element, opening a hole to the fuel. It is concluded that this defect was caused by contact with a latch in the coolant channel during a reverse fueling. The bundle operated in a defected condition for 28 months without significant deterioration. Author (NSA)

N67-20219# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
FAST FLUX TEST FACILITY, ADOPT: PROGRAM FOR STEADY-STATE PROCESS DESIGN AND COST OPTIMIZATION OF FFTF HEAT REMOVAL SYSTEMS USING HEAT DUMPS TO AIR
C. L. Goss and H. G. Johnson Sep. 1966 218 p refs
(Contract AT(45-1)-1830)
(BNWL-308) CFSTI: HC $3.00/MF $0.65

ADOPT, a computer program, was developed to provide process design and cost optimization data for the Fast Flux Test Facility's heat removal systems using an air heat dump. Complete sizing and cost data are calculated for the intermediate heat exchanger, dump heat exchanger complex, primary loops, and secondary loops for a given set of input, process, and basic equipment design data. Author (NSA)

N67-20291# Aktiebolaget Atomenergi, Stockholm (Sweden).
PERTURBATION METHOD OF ANALYSIS APPLIED TO SUBSTITUTION MEASUREMENTS OF BUCKLING
R. Persson Nov. 1966 59 p refs Submitted for publication
(AE-256) CFSTI: HC $3.00/MF $0.65

The one-group perturbation theory, combined with a new cell concept, is applied to substitution measurements of buckling. By making use of progressive substitutions the properties of the transition region can be regarded as fitting parameters in the evaluation procedure. Experiments on rod lattices in D_2O and on test regions of D_2O alone are analyzed. The lattice measurements, where the pitches differed by a factor of $\sqrt{2}$, gave excellent results, whereas the determination of the diffusion length in D_2O by this method was not quite successful. ESRO

N67-20300# Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorentwicklung.
DEVELOPMENT PROBLEMS OF A HIGH-TEMPERATURE THORIUM INCUBATE REACTOR [ENTWICKLUNGSPROBLEME EINES HOCHTEMPERATUR-THORIUM-BRUTREAKTORS]
R. Hecker Sep. 1966 31 p refs In GERMAN
(JUL-382-RG) CFSTI: HC $3.00/MF $0.65

Theoretical evaluation of the thorium cycle for gas cooled high-temperature reactors showed that: (1) this conversion system is economical even at a fuel price increase up to three times the current level; (2) it is possible to transform the converter into a breeder reactor with coated graphite fuel; (3) substitution of graphite elements with beryllium oxide could increase the breeding factor above 1; and (4) the use of a beryllium moderator and nuclear fuel can double nuclear burning phase in less than 10 years. Transl. by G.G.

N67-20374# Atomic Energy Establishment, Winfrith (England). Fast Reactor Physics Div.
THE EFFECT OF ENRICHMENT AND MODERATING MATERIALS ON THE SODIUM LOSS AND DOPPLER COEFFICIENTS OF FAST REACTORS
R. J. J. C. MacDonald May 1966 34 p refs
(AEEW-M-657) CFSTI: HC $3.00/MF $0.65

In safety studies of large fast reactors, two important factors are the reactivity changes arising from the Doppler effect and from loss of primary coolant. This memorandum examines the effect of enrichment and the addition of moderating material on these reactivity changes. It is concluded that the sodium loss reactivity change is mainly dependant on the fuel enrichment, though the addition of moderator does make the reactivity change less positive. The Doppler coefficient on the other hand is influenced more by the addition of moderator than by changes in enrichment. Author

23 PHYSICS, GENERAL

Includes acoustics, cryogenics, mechanics, and optics. For astrophysics see: 30 Space Sciences. For geophysics and related information see also: 13 Geophysics; 20 Meteorology; and 29 Space Radiation.

N67-19361# Israel Program for Scientific Translations, Ltd., Jerusalem.
ELECTRIC INSTRUMENTATION IN HIGH-ENERGY PHYSICS, COLLECTION OF PAPERS NO. 1
E. G. Komar, ed. 1966 193 p refs Transl. into ENGLISH of the book "Elektrofizicheskaya Apparatura, Sbornik Statei No. 1" Moscow, Gosatomi Zdat., 1963 p 1-202 Published for AEC and NSF
(AEC-TR-6636) CFSTI: HC $3.00/MF $0.65

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14. ELECTRICAL CHARACTERISTICS OF AN ARTIFICIAL LINE WITH LOAD DISTRIBUTION IN STEADY-STATE OPERATION M. F. Svin'in p 125-135 refs (See N67-19375 09-09)

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18. VACUUM CHAMBERS OF STRONG-FOCUSING SYNCHROTRONS I. F. Malyshev, A. V. Popkovich, P. A. Fefelov, and Yu. A. Sokolov p 160-169 refs (See N67-19379 09-11)

N67-19363# Israel Program for Scientific Translations, Ltd., Jerusalem.
MODIFICATION OF THE MAGNETIC STRUCTURE OF AN ISOCHRONOUS CYCLOTRON
Yu. G. Basargin *In its* Elec. Instrumentation in High-Energy Phys., Collection of Papers No. 1 1966 p 6-12 refs (See N67-19361 09-23) CFSTI: HC $3.00/MF $0.65

A modification of a magnetic structure with radial sector (RS) properties in the central part and spiral sector (SS) properties in the rest is discussed. Parameters of the model magnet were chosen so that the experimental magnetic field data can be used directly to study proton acceleration up to 60 MeV in a two-meter cyclotron. It is pointed out that, beginning with the intermediate radii, the shape of the magnetic field is such that focusing is accomplished principally at the expense of a sharp radial drop in the amplitude of the lowest harmonic of the azimuthal variation, which distinguishes the version from the SS type. At the end of the acceleration, the lowest harmonic approaches zero, and is therefore of use in beam deflection. Summary details are given on

the basis for the proposed version, the plan of the investigated magnetic structure, results of magnetic measurements, stability of vertical motion, and radial stability and beam deflection. L.E.W.

N67-19365# Israel Program for Scientific Translations, Ltd., Jerusalem.

RESULTS OF AN EXPERIMENTAL STUDY ON THE MAGNETIC STRUCTURE OF A SECTOR CYCLOTRON FOR WIDE PARTICLE ENERGY RANGE

A. G. Alekseev, Yu. G. Basargin, R. N. Litunovskii, and A. V. Stepanov *In its* Elec. Instrumentation in High-Energy Phys., Collection of Papers No. 1 1966 p 34–41 refs (See N67-19361 09-23) CFSTI: HC $3.00/MF $0.65

Results of magnetic measurements on different types of magnetic structures, which are applicable to synchrocyclotrons, are reported. The magnetic measurements were performed on two electromagnets with pole diameters of 342 and 685 mm respectively. The experiments with the smaller magnet were conducted to choose the most suitable magnetic structure for use of either a conventional system of dees or sector dees placed inside large gaps in a synchrocyclotron for use over a wide particle energy range. Four types of structure were investigated; particle motion stability was taken as the criterion. The layer electromagnet (685 mm) was used for detailed investigation of the properties of the magnetic structure. Author

N67-19366# Israel Program for Scientific Translations, Ltd., Jerusalem.

THE ALIGNMENT OF A SERIES OF CYCLOTRONS WITH 120 CM POLE DIAMETERS

A. G. Alekseev, B. P. Angelov, Yu. G. Basargin, L. N. Vaulin, M. D. Veselov et al *In its* Elec. Instrumentation in High-Energy Phys., Collection of Papers No. 1 1966 p 42–55 refs (See N67-19361 09-23) CFSTI: HC $3.00/MF $0.65

Industrial mass production and simultaneous alignment of cyclotrons is discussed. To ensure simultaneous alignment of the cyclotrons, the principal assemblies of an accelerator were laboratory checked and the prototype was stand tested. A method for assembly and alignment was developed concurrently. The assembly of the principal equipment is considered, and magnetic field measurement and correction are described. Acceleration of ions to final energy in the cyclotron chamber was carried out; to prevent excessive contamination of chamber parts the cyclotron was operated in pulses with an off-duty factor $\tau \sim 50$ to 100. The accelerated beam intensity measurement was performed by direct measurement of the current with probes (sondes). Obtaining an ion beam at a distant target is also discussed, as well as testing of the cyclotron systems in continuous operation. L.E.W.

N67-19368# Israel Program for Scientific Translations, Ltd., Jerusalem.

PERMALLOY DATA UNITS FOR MAGNETIC MEASUREMENTS

I. V. Mozin, V. P. Smirnov, and L. R. Sotnikov *In its* Elec. Instrumentation in High-Energy Phys., Collection of Papers No. 1 1966 p 60–65 refs (See N67-19361 09-23) CFSTI: HC $3.00/MF $0.65

The principle of operation of permalloy data units for magnetic measurements in accelerators is reviewed. It is pointed out that since pulse amplitude and duration are important characteristics of the unit with respect to accuracy, pulse duration should be as short as possible and the amplitude should be chosen to ensure normal operation of electronic instrumentation at the actual level of electromagnetic noise. Data units with toroidal magnetizing coils, in which there is no field dispersion, are described, and the problem of field correction is considered. A table is included that presents the dependence of the amplitude and half-width of data unit pulses on the permalloy core length and number of turns in the signal winding at an alternating magnetization rate. The tabulated data indicate that data unit dimensions can be reduced slightly if required. L.E.W.

N67-19369# Israel Program for Scientific Translations, Ltd., Jerusalem.

ION-OPTICAL SYSTEM COMPUTATION FOR DIRECT ACTION ACCELERATORS TAKING INTO ACCOUNT SPACE CHARGE

V. S. Kuznetsov *In its* Elec. Instrumentation in High-Energy Phys., Collection of Papers No. 1 1966 p 66–77 refs (See N67-19361 09-23) CFSTI: HC $3.00/MF $0.65

General relations between beam parameters at the entrance and exit of the accelerator tube are derived, and a method of computing optimum beam input parameters is given. The optimum beam parameters at the tube entrance, and possible relations between beam radii at the entrance and exit are considered. Shaping of the charged particle beam at the entrance of the accelerator tube by electrostatic focusing systems is discussed, emphasizing the entrance lens as the main focusing element. N.E.N.

N67-19370# Israel Program for Scientific Translations, Ltd., Jerusalem.

SOME PROBLEMS IN THE THEORY OF LOW-VOLTAGE ELECTRON DISCHARGES (MULTIPACTING)

V. I. Petrunin *In its* Elec. Instrumentation in High-Energy Phys., Collection of Papers No. 1 1966 p 78–96 refs (See N67-19361 09-23) CFSTI: HC $3.00/MF $0.65

The principal relations for resonance electron motion inside a flat gap are presented for application to resonators, and multipacting theory in volume resonators is reviewed. Phase and radial stability, and initial velocity effects are considered. Expressions are also given for the reactive properties of resonance charge and the energetic parameters for electron resonance. A method of suppressing multipacting by a steep voltage front, and the electronic means for its realization are outlined. Application of multipacting to obtain monoenergetic electron clusters is mentioned. N.E.N.

N67-19463*# Arkansas Univ., Little Rock.

THE SORTING OF HOLOGRAPHIC INFORMATION FOR TRANSMISSION

R. M. Jones *In its* Invest. of Laser Properties Relevant to the Meas. of Different Phys. Parameters 31 Dec. 1966 p 5–8 (See N67-19461 09-16) CFSTI: HC $3.00/MF $0.65

A proposal is described for transmitting information in a photograph so that the entire photograph would appear first in poor resolution with resolution increasing as more information is included. Information in a photograph would be sorted according to the size of areas in the photograph. This can be done by making a hologram at the point focus of the information beam. A focus hologram was made of a 35 mm color transparency. An interference filter reduced the reference beam intensity to approximately the diffracted light. The hologram plate was exposed for 2 minutes and developed. A series of reconstructions was made decreasing the aperture of the stop. The reconstructions had the appearance that the transparency would have had if viewed in a schlieren system. This was due to the greater amount of diffraction occurring near the bounderies and indicates that one could selectively transmit information related to the boundaries between areas, while transmitting little information relating to the broad areas of the photograph. The schlieren effect would not be observed except for the fact that the undeviated rays came to a focus on the plate and overexposed it. R.N.A.

N67-19466*# Arkansas Univ., Little Rock.

RESOLUTION CRITERIA IN HOLOGRAPHY

Jack G. Dodd and Landy Doyel *In its* Invest. of Laser Properties Relevant to the Meas. of Different Phys. Parameters 31 Dec. 1966 p 19–34 (See N67-19461 09-16) CFSTI: HC $3.00/MF $0.65

A study was conducted to evaluate the effects of varying the resolution capabilities of the holographic recorder to determine what types of holographic systems are best suited to the production of acceptable holograms on relatively low resolution media. A set of well-defined objects was selected whose theoretical transformation properties were simply calculable so that direct quantitative comparison between theoretical predictions and experimental results could be made whenever desirable. Holograms and reconstructions of these objects were made, varying the essential experimental parameters one at a time. The best possible hologram was made of each object on a scale that permitted recording the central maximum and at least the first three diffraction orders on each side of the maximum. In reconstruction, various orders were masked out to determine the effect of their loss on the quality of the reconstructed image. Conclusions concerning the film, aperture, suppression of sidebands, reference beam angle, beam intensity ratios, and laser characteristics are discussed. R.N.A.

N67-19467* Arkansas Univ., Little Rock.
FACTORS CONTRIBUTING TO THE DEGRADATION OF HOLOGRAPHIC IMAGES
George S. Ballard *In its* Invest. of Laser Properties Relevant to the Meas. of Different Phys. Parameters 1 Dec. 1966 p 35–45 (See N67-19461 09-16) CFSTI: HC $3.00

An attempt was made to identify factors which tend to degrade the hologram image and eliminate each of them from the hologram recording process, which would result in a high quality image. Results show that a number of factors other than aperture and film resolution adversely affect hologram image quality. Aberrations in the lenses used to form reference beams limit resolution and make it impossible to focus the entire image in one plane. Granularity in images arises from the use of diffuse illumination. The grain structure limits resolution and is irritating to the eye. The grain cannot be eliminated but may be minimized by increasing the aperture of the system. Grain structure is not greatly affected by moving the diffuser nearer or farther from the object. Air currents and factors arising from long exposure times adversely affect resolution. However, for the case of diffuse illumination, thermally induced air currents did not detract from the resolution and in one case improved it. R.N.A.

N67-19469# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
PROBLEM OF DIFFRACTION ON A LATTICE FROM ARBITRARY PROFILES
I. Ye. Tarapov 12 Sep. 1966 19 p refs Transl. into ENGLISH from Zh. Vychislitel'noi Mat. i Mat. Fiz. (Moscow), v. 5, no. 5, 1965 p 883–893
(FTD-HT-66-170; AD-644062) CFSTI: HC $3.00/MF $0.65

An examination was made of the use of integral equations to the problem of diffraction of flat waves on a lattice, formed by arbitrary profiles. Particular attention was given to a long wave approximation of the problem based on known Raleigh ideas (1). In this case, in contrast from the ordinary investigation, the use of integral equations allows strict use of the method of subsequent approximations and offers a principal possibility of evaluation of the errors. Author (TAB)

N67-19473# Naval Research Lab., Washington, D. C.
POTENTIAL AND MAGNETIC MOMENT OF A SUPERCONDUCTING TORUS IN A NONAXIAL UNIFORM MAGNETIC FIELD
Evan B. Wright and Paul I. Peterson 18 Oct. 1966 22 p refs
(NRL-6429; AD-644536) CFSTI: HC $3.00/MF $0.65

The magnetic constants of an ideal superconducting torus, located in a uniform magnetic field perpendicular to its axis of symmetry, are calculated from a scalar potential expansion in toroidal Legendre functions. An algorithm for finding the expansion coefficients, suitable for digital computation, is included. Graphs and approximate formulas are given for the induced magnetic moment of the torus and the maximum field values (with locations) on its surface, as functions of its radius ratio. Author (TAB)

N67-19509# Massachusetts Univ., Amherst. Polymer Research Inst.
PRINCIPLE OF THE DYNAMIC X-RAY DIFFRACTION TECHNIQUE
Tatsuro Kawaguchi Apr. 1966 38 p refs
(Contract Nonr-3357(01); Grant DA-ARO(D)-31-124-G468)
(ONR-TR-86; ITR-1; AD-644029) CFSTI: HC $3.00/MF $0.65

A mathematical analysis is made of data obtained by the dynamic x-ray diffraction technique. It is shown how by measuring the integrated diffraction intensity over a given interval of the strain cycle and accumulating results over many cycles of strain, the portion of the change in diffracted intensity which is in phase (delta I) and out of phase (delta I) with the applied sinusoidal strain may be obtained. The means for separating contributions of overlapping crystalline and amorphous peaks is discussed as is the determination of the dynamic orientation function by graphical integration of the change in diffracted intensity with azimuthal angle. Author (TAB)

N67-19548# Air Force Cambridge Research Labs., Bedford, Mass. Microwave Physics Lab.
COMPARISON OF REFLECTIVE PROPERTIES OF CORNER REFLECTOR CLUSTERS AND LUNEBURG LENS REFLECTORS Interim Scientific Report
F. S. Holt Aug. 1966 22 p refs *Its* Instrumentation Papers, No. 114
(AFCRL-66-626; AD-640577) CFSTI: HC $3.00/MF $0.65

The reflective properties of rectangular corner reflector clusters and Luneburg lens reflectors are analyzed, and the relative effectiveness and efficiency of these reflectors in producing large radar cross sections over a wide range of aspect angles is compared. The Luneburg lens reflector is found to be very effective and efficient, but is expensive, heavy, and difficult to repair. In contrast, the rectangular corner reflector cluster is inexpensive, repairable, and can be made lightweight, but is not an efficient reflector when used over wide ranges of aspect angles. Author (TAB)

N67-19551# RAND Corp., Santa Monica, Calif.
ON THE IDENTIFICATION OF SYSTEMS AND THE UNSCRAMBLING OF DATA. III: ONE-DIMENSIONAL WAVE AND DIFFUSION PROCESSES
R. Bellman, D. Detchmendy, H. Kagiwada, and R. Kalaba Oct. 1966 27 p refs
(Contract AF 49(638)-1700; Proj. RAND)
(RM-5173-PR; AD-640644) CFSTI: HC $3.00/MF $0.65

Three effective numerical approaches to a novel inverse problem in wave propagation and diffusion are presented. Given partial information concerning the solution of the telegraphers equation, various coefficient in the equation are determined using Laplace transforms, semidiscretization, and finite difference methods. Fields of application are radio-wave propagation, automatic control, and oceanography, where it is desired to determine the physical properties of an inhomogeneous medium based on observations of the response of the medium to an input signal. Author (TAB)

N67-19566# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
TECHNOLOGY OF INFRARED RADIATIONS

I. B. Levitin 29 Jul. 1966 72 p refs Transl. into ENGLISH of the book "Tekhnika Infrakrasnykh Izlucheniy, Issue 350" Moscow-Leningrad, Gosenergoizdat., 1959 p 1–80
(FTD-MT-65-133; TT-67-60310; AD-644071) CFSTI: HC $3.00/MF $0.65

The book acquaints radio amateurs with the bases of mechanics of infrared radiations which have at present various applications in science, the Peoples economy, military affairs, etc. It includes brief information about the nature of infrared radiations, their properties, methods of generation and reception, and also about basic applications in different branches of science and technology. TAB

N67-19575# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
THE PASSAGE OF LIGHT IN A DISPERSED DETECTOR
L. E. Pargamanik, M. A. Strzhemechnyy, and Yu. A. Tsirlin 2 Sep. 1966 13 p refs Transl. into ENGLISH from Zh. Prikl. Spektroscopii, Akad. Nauk Belorussk. SSR (Minsk), v. 2, no. 5, 1965 p 440–446
(FTD-HT-66-417; TT-67-60332; AD-644168) CFSTI: HC $3.00/MF $0.65

The problem of the propagation of the light of scintillation arising in a layer of a dispersed detector that is bounded by surfaces with different coefficients of reflection is solved. Optimal parameters of the detector are determined and a comparison is made with the available experimental data. Author (TAB)

N67-19617# Case Inst. of Tech., Cleveland, Ohio.
ELECTROMAGNETIC RADIATION IN A MOVING CONDUCTING MEDIUM: FIRST-ORDER THEORY
Ioannis M. Besieris Jun. 1966 53 p refs
(Contract AF 19(628)-1699)
(AFCRL-66-469; SR-13; AD-640853) CFSTI: HC $3.00/MF $0.65

The primary objective of the investigation was to examine the electromagnetic radiation resulting from sources of arbitrary time dependence in a homogeneous, isotropic, conducting medium of infinite extent. The material is assumed to be moving at a uniform velocity with respect to the rest frame of the source distribution. To avoid excessive difficulties in the ensuing development, only the non-relativistic approximation situation was considered. Because no solution to this problem could be found in the literature, it was considered worthwhile to find the modification of the character of the radiation due to the presence of conductivity. It is determined first that the electromagnetic field intensities referred to the laboratory system are expressible in terms of a pair of scalar and vector potential functions satisfying symmetric hyperbolic partial differential equations of the second order with respect to time and space coordinates. This is made possible by invoking a generalized Helmholtz theorem, and specifying a new type of Lorentz condition. Ordinarily, one would proceed to solve for the time-dependent Greens function associated with the potential equations by using both time and space Fourier transformations. Instead of following this classical approach, however, the author introduced an alternative method which is based on the fact that there exists a relation between the fundamental solution of a radiation problem and that of a corresponding Cauchy initial-value problem. TAB

N67-19663# Marine Engineering Lab., Annapolis, Md.
A METHOD FOR DETERMINING TRANSMISSION LOSS THROUGH SHIP HULLS
George A. Guedel Sep. 1966 18 p refs
(MEL-332/66; AD-638021) CFSTI: HC $3.00/MF $0.65

A method for using an impulse noise source to determine the sound transmission loss through ship hulls is described. If fully developed it would have many advantages over the direct steady-state techniques now in use. Experimental verification did not produce fruitful results, however, because of the difficulty in analyzing the response traces which were of long duration due to reverberation effects. Other possible techniques for performing this analysis are suggested. Author (TAB)

N67-19849*# Illinois Univ., Urbana. Antenna Lab.
A NEAR-FIELD SOLUTION FOR AN INFINITE LINE SOURCE ABOVE A DIELECTRIC COATED CONDUCTING PLANE Interim Technical Report
G. F. Van Blaricum and R. Mittra Aug. 1966 43 p refs *Its* Antenna Lab. Rept.-66-13
(Grant NsG-395; Contract AF 19(628)-3819; Proj. 5635)
(NASA-CR-82990; AFCRL-66-700; TR-10; AD-643773) CFSTI: HC $3.00/MF $0.65

The fields along a dielectric slab excited by a line source are found by considering the inversion integral of a Fourier transform directly rather than by resorting to the usual saddle point approximation techniques. The field at any point along the surface is expressed as a superposition of traveling waves plus a spacewave contribution, and conditions under which the field may be approximated by traveling wave components alone are discussed. Results of sample computations for both electric and magnetic current excitation are given. Author (TAB)

N67-19930# Naval Research Lab., Washington, D. C.
REPORT OF NRL PROGRESS SCIENTIFIC HIGHLIGHTS FOR 1966
Dec. 1966 59 p refs
(PB-173681) CFSTI: HC $3.00/MF $0.65

Summary data are presented from various research projects in the general areas of electronics, materials science, and general sciences. In electronics research emphasis was placed on the development of superconductors and power supplies and the application of study results to civilian industry. Satellite radio transmission and signal processing techniques were also investigated. Materials studies were focused on chemical analysis methods, lubricant synthesis, flammability prediction, compression properties of glass materials, corrosion prevention, and ferromagnetism. General sciences research was concentrated on radio astronomy equipment development, nuclear reaction experiments, electron probe microanalysis, and laser system development. A.G.O.

N67-19940# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
A DEVICE FOR DEFLECTING A LIGHT BEAM
V. A. Shamburov 2 Sep. 1966 6 p Transl. into ENGLISH from Russian Patent no. 170074 (Appl. no. 876073/26-25, 14 Jan. 1964) p 1–3
(FTD-HT-66-93; AD-643710) CFSTI: HC $3.00/MF $0.65

The object of the invention is a device for deflecting a light beam based on the electro-optical effect is different in that, to increase the speed of response, it is made in the form of an elongated rectilinear parallelepiped composed of two or more trigonal prisms that are made from electro-optical crystals; the light strikes the face of the parallelepiped whose lateral sides are covered with electrodes. The device described in paragraph 1 is different in that, to use it as the light valve in a laser, it is placed between the external mirrors of the laser, which are set at an angle to each other. Author (TAB)

N67-19945*# Illinois Univ., Urbana. Coordinated Science Lab.
STUDIES RELEVANT TO THE ELECTRIC VACUUM GYRO PROGRAM OF ELECTRICAL BREAKDOWN IN ULTRAHIGH VACUUM Final Report

Ernest M. Lyman Jan. 1967 63 p refs
(Grant NGR-14-005-038; Contract DA-28-043-AMC-00073(E))
(NASA-CR-82954; R-334) CFSTI: HC $3.00/MF $0.65 CSCL 20C

Experimental measurements were made to determine the effect of gas-conditioning in suppressing field emission current and improving the voltage holding capacity of plane tungsten electrodes in ultrahigh vacuum. Apparatus was constructed and experiments were conducted to study the work function of portions of a tungsten emitter tip exhibiting the flicker effect in field emission. Experiments were performed to study the formation mechanism of metallic protuberances or whiskers on the cathode which cause electrical breakdown in ultrahigh vacuum. Investigated were the effects on the voltage-current characteristics of a teflon pad cemented to the molybdenum electrode of a molybdenum–beryllium pair of plane electrodes. A major effort was made to develop a physical explanation of various aspects of the electrical breakdown problem. K.W.

N67-19963# Naval Research Lab., Washington, D. C.
REPORT OF NRL PROGRESS
Nov. 1966 31 p refs
(PB-173549) CFSTI: HC $3.00/MF $0.65

An article on the thermal conductivity of high purity rhenium at 2°K to 20°K and technical progress in the areas of chemistry, electricity, mechanics, metallurgy and ceramics, nuclear and atomic physics, optical physics, and satellite radio communications are presented. In the thermal conductivity article it is shown that the simple power law cannot be used to describe the temperature dependence of the idealized thermal resistivity. In the chemistry area the following topics are discussed: (1) thin layer chromatography for identification of aircraft engine oil components, (2) dry film lubricants from molybdenum disulfide bonded with boehmite, (3) organic adsorption at electrodes, and (4) perturbation times in alkali halide systems. The preparation of CrFe alloys and proton damage to silicon solar cells are discussed in the electricity area. Mechanics investigations were made of the plane strain fracture toughness of aluminum alloys. Metallurgy and ceramics studies include environmental fatigue; notch ductility behavior of steel with multiple irradiation-annealing cycles; and fractographic, stress corrosion, and cracking studies. Other investigations include the development of a vacuum clamp switch for the Pharos 2 megajoule capacitor bank; preparation of radiophotoluminescent sulfates of ammonium, and a computer program to calculate the components of the earth's magnetic field. C.T.C.

N67-19964# Naval Research Lab.; Washington, D. C.
REPORT OF NRL PROGRESS
Oct. 1966 41 p refs
(PB-173468) CFSTI: HC $3.00/MF $0.65

Articles covering a nuclear method for detecting sulfur in thin films and absorption in the atmosphere by the oxygen dimer $(O_2)_2$ complex at 1.06 microns are presented. Included are problem notes in the areas of applications research, chemistry, mechanics, metallurgy and ceramics, optical physics, radio communications, and sound. C.T.C.

N67-19998* General Electric Co., Philadelphia, Pa. Missile and Space Div.
INITIAL DESIGN STUDY OF A PERMANENT MAGNET FOR USE WITH AN MPD ARC THRUSTER Final Report
A. C. Eckert and D. B. Miller 11 Jan. 1967 70 p refs
(Contract NAS3-7923)
(NASA-CR-54690) CFSTI: $3.00 CSCL 20C

A permanent magnet containing an active magnetic material and flux return circuit to be used as the magnetic field source was designed, fabricated, and tested. The magnet provides a volume 4 inch. long and 2 inch. in diameter in which a solenoidal field is approximated. Maximum on-axis flux density up to 1800 gauss was obtained. Associated with the magnet geometry is a field reversal point which falls outside the 4 inch by 2 inch diameter region. Using Alnico 8, the magnet weight is 150 lbs. Scaling relations were used to determine the weight of an Alnico 9 magnet providing 2000 gauss at the center of the 4 inch long by 2 inch dia. region. The result was a system weighing 261 lbs. which exceeded the weight of a bar magnet of Alnico 9 (168 lbs.) providing the same field. The weight of a system consisting of a bar magnet and a solenoid was found to be less than that of the highest system containing only permanent magnets. Temperature stability testing using Alnico 8 demonstrated that irreversible losses, up to 8.0% at 300°C and 9.4% at 500°C, occur during the first magnet heat-up after magnetizing. No further irreversible loss occurs during subsequent heating if the maximum temperature of the first heat-up is not exceeded. The reversible losses occurring during heat-up were less than 1%. Author

N67-20205# Bundesministerium fuer Wissenschaftliche Forschung, Bad Godesberg (West Germany).
THE DESORPTION OF RaE FROM Ni- AND Au-SURFACES IN HIGH VACUUM [DIE DESORPTION VON RaE AUF-NICKEL- UND GOLDOBERFLAECHEN IN VAKUUM]
J. Dierker and R. Trier Jul. 1966 30 p refs In GERMAN
(BMwF-FBK-66-17) CFSTI: HC $3.00/MF $0.65

In order to determine the desorption probability for ^{210}Bi on Ni and Au surfaces an apparatus was constructed, which allows active and inactive materials to be evaporated, the activity to be measured as a function of time at several temperatures in high vacuum. The measured time dependence of the activity on the surfaces at several constant temperatures between 630 and 850°K can be separated in two parts with different desorption probability. The adsorption energy E_{ad}, according to the first part of the curve, which has an exponential form, was determined to be E_{ad} (^{210}Bi on Ni) = 2.05±0.18 eV and E_{ad} (^{210}Bi on Au) = 2.46±0.21 eV. Author (NSA)

N67-20270*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
ON THE MOTION OF CONDUCTORS IN A MAGNETIC FIELD
W. H. Heybey *In its* Aero-Astrodyn. Res. Rev. No. 5 15 Oct. 1966 p96–106 *ref* (See N67-20261 09-34)

The movements within a magnetic field of certain conducting configurations are studied on the basis of fundamental electromagnetic theorems. The field vector is not allowed to vary with time; if it varies in space, the motion of a loop is alone describable without extraordinary complications. Less involved relations are developed holding in a homogeneous field. It is shown that such a field has no effect on the translatory motion; the rotatory motion is retarded in general, although in special circumstances it may continue undisturbed. A principle of maximum retardation is introduced to define the systems of induced currents in two-dimensional bodies. It is applied to closed shells, with the sphere as simplest example, and to the circular disc. The motion of the latter is also studied when in addition the surface is subjected to the pressure of sunlight and is carrying an electric charge. The presence of the charge alone, if of constant density, would cause the mass center to wander on a spiral about a field line, while the disc performs a gyroscopic motion about shifting axes through the mass center. Author

N67-20280# European Organization for Nuclear Research, Geneva (Switzerland). Synchrotron Proton Machine Div.

OPTICS OF PRIMARY BEAMS. ANALYTIC TREATMENT OF A NON-UNIFORM DENSITY IN PHASE SPACE [OPTIQUE DES FAISCEAUX PRIMAIRES. TRAITEMENT ANALYTIQUE D'UNE DENSITE NON UNIFORME DANS L'ESPACE DES PHASES]

C. Bovet 1966 31 p refs In FRENCH; ENGLISH summary (CERN-66-25)

When an external target (or even several external targets in series) is used, then primary beam optics are relevant to the transfer of the beam from the extraction point to the targets. A primary beam is characterized by a non-uniform density in the transverse phase space (y, dy/ds, z, dz/ds). An analytical formula to this density is given, and also definitions of emittance and beam envelope, which may be calculated at every point of the transfer system. The analysis allows us to consider linear elements as well as the effects of diffusing media (energy loss and multiple scattering) and also the dispersion effects of the bendings, due to $\Delta p/p$. (One obtains, therefore, the increase of the emittance when a beam traverses a volume of material or undergoes deflections.) A FORTRAN program is available. Author (NSA)

24 PHYSICS, ATOMIC, MOLECULAR, AND NUCLEAR

Includes atomic, molecular, and nuclear physics. For applications see: 22 Nuclear Engineering. For related information see also: 29 Space Radiation.

N67-19362# Israel Program for Scientific Translations, Ltd., Jerusalem.

DEFLECTION OF AN ACCELERATED BEAM TO THE INTERNAL TARGET IN A STRONG-FOCUSING SYNCHROTRON

I. A. Shukeilo *In its* Elec. Instrumentation in High-Energy Phys., Collection of Papers No. 1 1966 p 1–5 refs (See N67-19361 09-23) CFSTI: HC $3.00/MF $0.65

Equations are formulated to illustrate a method of achieving an azimuthally symmetric local orbit perturbation with respect to the target. It is assumed that the magnet system of the synchrotron is symmetric with respect to the azimuthal origin. The perturbation is achieved by special windings on to the magnetic units in addition to the main windings for synchrotron electromagnet excitation. It is pointed out that the beam deflection elements do not occupy the gaps between the units, and that the interaction time between beam and target is easily adjusted by variation of the voltage on the windings. The polarity of this voltage determines the direction of the deflection. Inductive coupling with the main electromagnet windings was taken into consideration in designing the supply system for the excitation windings. This method can be used to deflect the beam from the vacuum chamber in accelerators that use laminated electromagnets when the perturbation increases quickly enough. L.E.W.

N67-19420# Carnegie Inst. of Tech., Pittsburgh, Pa. Dept. of Chemistry.

NUCLEAR CHEMISTRY AND GEOCHEMISTRY RESEARCH, CARNEGIE INSTITUTE OF TECHNOLOGY, 1965–1966 Progress Report

30 Jun. 1966 67 p refs

(Contracts AT(30-1)-844; AT(30-1)-3624) (NYO-844-67) CFSTI: HC $3.00/MF $0.65

Research activities in nuclear chemistry, nuclear geology, nuclear reaction studies and instrumentation are summarized. Laboratories, instruments, and irradiation facilities used are described. Lists of publications published and in preparation are included. NSA

N67-19455# California Univ., Santa Barbara. Physics Dept.

SPECTRAL ANALYSIS OF MECHANISMS AND KINETICS OF THERMAL ENERGY REACTIONS OF LONG-LIVED ENERGETIC HELIUM SPECIES WITH SIMPLE MOLECULES

Jerry L. Dunn (Ph.D. Thesis) Nov. 1966 153 p refs

(Contract Nonr-4222(01); ARPA Order 125) (TR-20; AD-644814) CFSTI: HC $3.00/MF $0.65

An optical spectroscopic technique for determining rate coefficients was developed and utilized for measuring the decrease in energetic helium as a function of added reactant concentration. Relative concentration measurements of the helium species were made by introducing a second reactant to the afterglow and monitoring relative intensities of the resulting spectra. Individual reactions involving single helium species were studied by observing transitions of the second reactant whose upper states were preferentially excited by the energetic helium species to be measured. Rate coefficients were limited to the range of 10 to the -9th power to 10 to the -13th power cc/sec. Penning ionization reactions with metastable He and ion-neutral reactions with He(+) were compared to published values. Overall agreement of the rates reported in these experiments and published values measured by optical absorption and mass spectrometric techniques gives confidence in the general method. In addition, nitrogen spectra selectively excited in a helium afterglow were studied in order to understand details of the excitation processes. Author (TAB)

N67-19474# Argonne National Lab., Ill.

PHYSICS DIVISION Summary Report, Mar.–Apr. 1966

Lowell M. Bollinger Apr. 1966 78 p refs

(Contract W-31-109-ENG-38) (ANL-7198) CFSTI: HC $3.00/MF $0.65

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N67-19475# Argonne National Lab., Ill.

RESEARCH HIGHLIGHTS: MEASUREMENT OF THE ELECTRON–NEUTRON INTERACTION BY THE ASYMMETRICAL SCATTERING OF THERMAL NEUTRONS BY NOBLE GASES

V. E. Krohn and G. R. Ringo *In its* Phys. Div. Apr. 1966 p 1–3 (See N67-19474 09-24) CFSTI: HC $3.00/MF $0.65

The results of recent precise determinations of the electron–neutron interaction with low energy neutrons are discussed.

The approach used was to make measurements on each of three gases by the method originally employed by Fermi and Marshall. This method depends on the fact that, in the scattering of thermal neutrons, the interference between the scattering from the nucleus and the scattering from the electrons of an atom leads to an asymmetric angular distribution of scattered neutrons in the center-of-mass system. In terms of the slope of the electric structure factor of the neutron at zero momentum transfer, the values obtained were 0.0196 ± 0.0013 F^2 from Ar, 0.0197 ± 0.0007 F^2 from Kr, and 0.0190 ± 0.0005 F^2 from Xe. The agreement between these results suggests that the final result has not been seriously affected by any possible weak p-wave resonance in one of the noble gas isotopes. The final result is 0.0193 ± 0.0004 F^2, which corresponds to an electron–neutron scattering length of $-1.34 \pm 0.03 \times 10^{-18}$ cm and an effective potential of -3720 ± 90 eV. R.N.A.

N67-19477# Argonne National Lab., Ill.
GAMMA-RAY COINCIDENCE TECHNIQUES EMPLOYING HIGH-RESOLUTION GERMANIUM DETECTORS
H. H. Bolotin *In its* Phys. Div. Apr. 1966 p 6–8 (See N67-19474 09-24) CFSTI: HC $3.00/MF $0.65

The technique of coincidence measurements with high resolution lithium-drifted germanium diode detectors is described. It is being used to investigate the highly complex gamma ray spectra following capture of slow neutrons. Information obtained on the properties of low-lying excited states of odd–odd nuclei is illustrated by recent results on Ga^{72} from neutron capture in Ga^{71} and on Ga^{66} from beta decay of Ge^{66}. The lithium-drifted germanium diode detectors combine extremely high energy resolution, moderate detection efficiency, and reasonably fast coincidence timing capabilities. The typical complexity of gamma ray spectra following slow neutron capture is shown by the spectrum of low energy transitions from the reaction $Ga^{71}(n,\gamma)Ga^{72}$, as viewed by a lithium-drifted germanium diode detector. The resolved transitions in this single spectrum are numerous enough that, with the aid of the spectra of low energy transitions in coincidence with high energy primary gamma rays and with gamma rays occurring between lower energy levels, members of many unresolved multiplets are identified and unambiguous coincidence relationships are provided. R.N.A.

N67-19478# Argonne National Lab., Ill.
LIFETIME MEASUREMENTS BY THE DOPPLER-SHIFT METHOD
R. E. Segel, R. H. Siemssen, A. E. Blaugrund, S. I. Baker, G. C. Morrison et al *In its* Phys. Div. Apr. 1966 p 9–10 ref (See N67-19474 09-24) CFSTI: HC $3.00/MF $0.65

It takes typically about 10^{-13} sec for the recoil nucleus produced in a nuclear reaction to come to rest. If the nucleus emits a gamma ray, the energy of the gamma ray is modified according to the Doppler-shift formula $E_\gamma = E_{\gamma 0}(1 + v/c \cos \theta)$, where $E_{\gamma 0}$ is the energy of a gamma ray emitted when the nucleus is at rest. Thus, if the direction of the recoiling nucleus is known, a measurement of the gamma-ray energy determines the recoil velocity at the time of emission. Since the initial recoil velocity can be fixed by the reaction kinematics and since for most combinations of recoil nucleus and stopping material the rate of slowing down can be computed, the lifetime of the state can be extracted from a measurement of the (average) Doppler shift. The method is useful for measuring lifetimes in the range from 10^{-12} to 10^{-14} sec if the resolution of the detector is good enough to measure energy differences as small as the Doppler shift associated with the typical $v/c \sim 0.5\%$. Doppler shift measurements with high-quality lithium-drifted germanium detectors have disclosed an interesting situation in Ca^{41}. Author

N67-19555# Oak Ridge National Lab., Tenn. Neutron Physics Div.
A NOTE ON SUBROUTINE CEASE(05R:EVAP), A MODIFICATION OF EVAP IN 05R
E. A. Straker and V. R. Cain 31 Aug. 1966 6 p refs
(DASA Order EO-802-65; DASA Order EO-800-64)
(ORNL-TM-1552; AD-639671) CFSTI: HC $3.00/MF $0.65

The note concerns the use of the evaporation model for inelastic scattering in light nuclei. Also, modifications have been made to the 05R subroutine EVAP to provide better continuity in the scattered neutron energy distribution determined from level structure data and from the evaporation model. A selection technique for picking from the distribution is also given. Author (TAB)

N67-19568# Texas Univ., Austin. Dept. of Physics.
THE PHYSICS OF METASTABLE SYSTEMS Final Report, 1 Feb. 1965–31 Jan. 1966
W. W. Robertson 31 Jan. 1966 14 p refs
(Grant AF-AFOSR-273-65)
(AFOSR-66-2280; AD-640630) CFSTI: HC $3.00/MF $0.65

Results of studies in the following areas are briefly summarized: Collisional-radiative recombination of He(+) into dissociative states; temperature dependence of the rate of conversion of He(+) into He2(+); atomic and molecular emission in the negative glow of a helium discharge; spectroscopic investigation of the helium-neon molecule; application of the Franck-Condon principle to molecular excitation by collision with excited atoms and molecules; Hornbeck-Molnar cross-sections for the n=3 states of helium; inelastic excitation transfer in helium. A cumulative list of publications generated under the contract is included. TAB

N67-19660# Instituto de Investigation Aeronautica y Espacial, Buenos Aires (Argentina). Laboratorio de Radiaciones.
DISINTEGRATION OF Sn^{113+} Interim Report, 15 Mar. 1965–15 Mar. 1966
H. E. Busch, M. C. Simon, E. Szichman, L. Gatto, and S. M. Abecasis Jul. 1966 31 p refs
(Grant DA-ARO-49-092-65-G78)
(LR-10; AD-641746) CFSTI: HC $3.00/MF $0.65

A reinvestigation of the decay of 119-d tin-113 was carried out with scintillation as well as with lithium-drifted silicon- and germanium-detectors. In addition to X rays, two gamma rays of 0.2555 plus or minus 0.0005 and 0.3910 plus or minus 0.0005 MeV were found in relative intensity (2.9 plus or minus 0.3)x0.01. The K-conversion coefficient of the 0.2555-MeV transition was measured to be 0.042 plus or minus 0.010 and that of the 0.3910-MeV one, 0.49 plus or minus 0.04 (K/LM=4.2 plus or minus 0.4). The electron-capture ratio P sub EC (LM...)/P sub EC(K) to the 0.6465-MeV level of indium-113 was determined to be 0.36 plus or minus 0.20. The bremsstrahlung end-point energy to the same level was (0.080 plus or minus 0.005) MeV. From these values the decay-energy transitions to that level was deduced to be 0.050-0.170 MeV and (0.110 plus or minus 0.005) MeV, respectively. A decay scheme is constructed and reasonable shell-model as well as microscopic models assignments are made to all levels. Author (TAB)

N67-19704# Smithsonian Astrophysical Observatory, Cambridge, Mass.
STUDIES OF METASTABLE MOLECULES OF ATMOSPHERIC INTEREST Final Report, 1 Jun. 1964–31 Aug. 1966
Nathaniel P. Carleton Oct. 1966 55 p refs
(Contract AF 19(628)-4203)
(Rept.-9-66-13; AFCRL-66-717; AD-642851) CFSTI: HC $3.00/MF $0.65

Work relating to the study of metastable states of atoms and molecules of atmospheric interest. Excitation of such states was investigated by electron impact, reaction rates of the excited species with various molecules and also radiative lifetimes, and, as an experimental tool, the interaction of metastable molecules with surfaces. Related to this last topic is an investigation of negative-ion formation at heated surfaces. The chief application of this work to atmospheric physics is in relating various observational data to the fundamental input of energy into the atmosphere by photoionization and the precipitation of fast charged particles. TAB

N67-19760# Stanford Univ., Calif. High Energy Physics Lab.

ETA PHOTOPRODUCTION IN THE REGION FROM THRESHOLD TO 940 MeV

Richard Prepost, David Lundquist, and Dan Quinn Nov. 1966 15 p refs Submitted for publication

(Contract Nonr-225(67))

(HEPL-465; AD-643164) CFSTI: HC$3.00/MF$0.65

The differential cross section for eta photoproduction in the reaction gamma + p to eta-null + p was measured from threshold to 940 MeV in approximately 25 MeV intervals near 90 deg. in the c.m. An angular distribution was measured at 790 MeV. The results are characterized by a rapid rise of the cross section near threshold reaching a maximum value of approx 1 microbarn/sr approximately 40 MeV above threshold. The angular distribution near threshold is consistent with isotropy. The results suggest that eta photoproduction near threshold is to be identified with the resonant N*1/2(1550 MeV)S11 state. Author (TAB)

N67-19853# Mound Lab., Miamisburg, Ohio.

WEAK ALPHA AND ELECTRON-CAPTURE DECAY IN POLONIUM-208 AND POLONIUM-209

G. R. Hagee (Ph.D. Thesis—Cincinnati Univ.), R. C. Lange, and J. T. McCarthy 11 Nov. 1966 58 p refs

(Contract AT(33-1)-GEN-53)

(MLM-1251) CFSTI: HC$3.00/MF$0.65

The weak alpha and electron capture decay modes of polonium 208 and polonium 209 were investigated. Previously unobserved alpha groups were found at 4.22 MeV with 2.44×10^{-4}% abundance in polonium 208 decay and at 4.11 and 4.31 MeV with 5.66×10^{-4}% abundances, respectively, in polonium 209 decay. The 4.617 MeV apha group in polonium 209 was measured explicitly and found to have 0.48% branching. Electron capture branchings in polonium 208 and polonium 209 were measured as 1.81×10^{-3}% and 0.263% respectively. Predominant electron capture feeding in polonium 208 populates a 921 keV level in Bi-208. The log ft value of this transition was determined to be 13.7 in agreement with its assignment as a second forbidden transition ($\Delta I=2$, $\Delta\pi=NO$). Gamma rays following electron capture decay in polonium 208 were found at energies of 65, 291, 534, 565, 599, and 865 keV. Measurements of internal conversion coefficients of K to L+M shell conversion electron ratios on the 291, 534, 565, and 599 keV transition in polonium 208 or 263 and 900 keV transitions in polonium 209 show them to be pure M1 or mixed M1+E2 transitions. Author

N67-19921*# TRW Systems, Redondo Beach, Calif.

IONIZATION FROM Fe ATOMS INCIDENT ON VARIOUS GAS TARGETS

J. F. Friichtenicht, J. C. Slattery, and D. O. Hansen Nov. 1966 23 p refs

(Contract NASw-1336)

(NASA-CR-82969; TRW-05320-6004-R000) CFSTI: HC $3.00/MF $0.65 CSCL 20H

Ionization probabilities, β, have been measured for iron atoms incident upon target gases of He, Ne, N_2, CO_2, and air. The energetic Fe atoms are obtained by injecting solid iron particles of known velocity and mass into a low pressure gas target where collisional heating raises the temperature of the particle to the vaporization point. Atoms evaporated from the particle traverse the gas at a velocity essentially equal to the velocity of the solid particle and these atoms constitute the atomic "beam". For velocities in excess of ≈20 km/sec the incident particle is completely vaporized and the number of atoms injected into the target gas, N_A, is specified by the particle mass. The number of ions produced in the target volume, N_I, is determined by means of a parallel plate ionization chamber. By definition, $\beta=N_I/N_A$. An estimated value of the ionization cross-section σ_I can be obtained from these results and for the particular case of Fe atoms incident on a N_2 target, the data are in qualitative agreement with published data obtained using more conventional techniques. Author

N67-20144# General Electric Co., Cincinnati, Ohio. Nuclear Technology Dept.

PROGRAM AVOID, NMP-838: A FORTRAN IV PROGRAM FOR EVALUATING THE EQUIVALENT DIFFUSION COEFFICIENT AND LOSS CROSS SECTION OF AN ANNULAR VOID IN CYLINDRICAL REACTORS

W. B. Henderson 15 Apr. 1966 33 p refs

(Contract AT(40-1)-2847)

(GEMP-424) CFSTI: HC$3.00/MF$0.65

Given the inner and outer radii of a void annulus, the neutron flux ratio across the annulus, and the effective escape probabilities for neutrons entering the void, program AVOID computes the effective diffusion coefficient, D, and lose cross section Σ_L, which are consistent with a P_1 flux expansion in the void. Author (NSA)

N67-20157# Comissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires.

VIBRATIONAL AND CASCADE DISSOCIATION OF H_2^+ IONS BY COLLISION WITH GAS MOLECULES [DISSOCIATION VIBRATIONNELLE ET DISSOCIATION EN CASCADE D'IONS H_2^+ PAR COLLISIONS AVEC LES MOLECULES D'UN GAZ]

Philippe Verveer (Ph.D. Thesis—Paris Univ.) Jul. 1966 58 p refs In FRENCH Supported in part by EURATOM

(CEA-R-2983; EUR-2767.f)

Protons produced by collisional dissociation of H_2^+ ions have an energy spectrum with a narrow central peak. For a part the protons in this peak are produced by vibrational dissociation and for another part by a cascade of two collisions. For H_2^+ ions of 50 to 150 keV, the cross section for vibrational dissociation is about 4.1×10^{-19} cm^2/mol in hydrogen and $1.1\times10^{-18}cm^2$/mol in argon. Author (NSA)

N67-20158# Brookhaven National Lab., Upton, N. Y. Accelerator Dept.

TRANSVERSE BEAM GROWTH DUE TO LONGITUDINAL COUPLING IN LINEAR ACCELERATORS

R. L. Gluckstern (Mass. Univ.) 1 Sep. 1966 14 p refs Presented at the LASL Linear Accelerator Conf., Los Alamos, N. Mex., 3–7 Oct. 1966

(Contract AT(30-2)-GEN-16; Grant NSF GP-4476)

(BNL-10667; AADD-120; CONF-661021-7) CFSTI: HC $3.00/MF $0.65

Coupling of the longitudinal and transverse motion takes place through the phase dependence of the r-f defocusing force and the radial dependence of the longitudinal transit time factor. Both of these effects arise from the same term in the Lagrangian. An analysis is presented that yields a result for the second order term which takes into account higher order terms in the first coupling term. This result appears to be in general agreement with the orbit computations and can be used as the basis for predicting transverse beam growths due to the coupling. NSA

N67-20178# California Univ., Berkeley. Lawrence Radiation Lab.
STRUCTURAL INCONSISTENCY OF THE QUANTUM ELECTRODYNAMICS OF HIGHER SPIN FIELDS
Mark Frank Sharefkin (Ph.D. Thesis) Aug. 1966 72 p refs
(Contract W-7405-ENG-48)
(UCRL-17139) CFSTI: HC $3.00/MF $0.65

A structural classification of Duffin-type Lagrangians serves to introduce several simple consistency conditions, and motivates the construction of an aberrant vector theory structurally similar to boson theories of spin ≥ 2. The corresponding minimal electrodynamics is shown to violate microscopic causality: any nonzero coupling generates terms in the equal-time self commutator of the charge density operator which are nonzero outside the light cone. The requirement that this commutator be local is therefore a nontrivial restriction on the Lagrangian, and it is not obvious that a spin-2 Lagrangian consistent with this requirement can be found. Author (NSA)

N67-20180# Commissariat a l'Energie Atomique, Chuscian (France). Centre de Production de Plutonium de Marcoule.
STUDY OF THE PERMEABILITY OF CERTAIN MATERIALS TO TRITIUM [ETUDE DE LA PERMEABILITE AU TRITIUM DE DIFFERENTS MATERIAUX]
Bernard Caire and Yves Sutra-Fourcade Aug. 1966 20 p In FRENCH
(CEA-R-3018)

Certain materials intended for use as a protection against gaseous tritium and tritiated water are classified. Active tests are discussed and an account is given of phenomena encountered with very small quantities of the element. Tests carried out using helium and inactive water are reported. Gaseous tritium was used without a carrier and, for safety reasons, it was not possible to handle it in weighable amounts. One mCi of tritium corresponds to 10^{-7} g of this gas. At a concentration of one mCi/m^3 one has therefore 10^{-7} g/m^3 of tritium. Under the same conditions, at normal pressure, a cubic meter of hydrogen weighs 900 gms. The amounts handled during the active tests are thus 10^{10} times less than those which would have been used in the case of hydrogen at normal pressure. Author (NSA)

N67-20193*# Naval Radiological Defense Lab., San Francisco, Calif.
CHARGED PARTICLE TRACKS IN POLYMERS: No. 3—RANGE AND ENERGY LOSS TABLES
Richard P. Henke and Eugene V. Benton 21 Nov. 1966 39 p refs
(NASA Order A-65315)
(NASA-CR-83033; USNRDL-TR-1102; AD-644273) CFSTI: HC $3.00/MF $0.65 CSCL 20H

The range and energy loss rate for the ions 1H, 4He, 12C, 16O, 20Ne, 28Si, 40Ar, 56Fe, and 84K are given in the energy/nucleon interval 0.1 - 1200 MeV/amu. These quantities are tabulated for the stopping materials cellulose nitrate, cellulose acetate butyrate, HBpaIT polyester, Lexan, Mylar, muscovite and phlogopite mica, soda lime and phosphate glass and olivine. The values for a given stopping material can be extended to other materials with similar values of the mean excitation potential by simple scaling. The computation involved a published mathematical method which was modified and extended to lower energies. Author (TAB)

N67-20209# Atomic Energy of Canada, Ltd., Chalk River (Ontario).
RECENT WORK WITH Ge(Li) γ-RAY SPECTROMETERS AT CHALK RIVER
G. T. Ewan, H. L. Malm, and I. L. Fowler Jul. 1966 58 p refs Presented at the IAEA Panel Meeting on use of Germanium Lithium-Drift Gamma-Ray Detectors, Vienna, 6–10 Jun. 1966
(AECL-2607; CONF-660625-3) Available from Atomic Energy of Canada, Ltd., Chalk River: $1.00

A review is given of some recent work with Ge(Li) detectors at Chalk River. The development and properties of large volume coaxial detectors are discussed briefly and typical results of measurements of the resolution, efficiency, and peak-to-total ratios for these detectors are presented. Results of performance tests on encapsulated detectors are summarized. Some of the factors affecting the pulse shape from Ge(Li) detectors are considered and time-distribution measurements from coaxial detectors are shown. These detectors are being used in a Ge(Li)–Ge(Li) γ–γ coincidence arrangement and typical results are given. The use of the detectors in the experimental program at Chalk River is discussed briefly, with results from a few experiments chosen to illustrate their different applications. These include their use in experiments on nuclear decay schemes, γ rays from nuclear reactions, neutron capture γ rays, resonance γ-ray scattering, muonic X-rays, and experiments associated with nuclear reactor development. Author (NSA)

N67-20216# Deutsche Akademie der Wissenschaften zu Rossendorf (East Germany).
FORMAL SCATTERING THEORY [FORMALE STREU-THEORIE]
Alfred Pfitzner Jan. 1966 47 p refs In GERMAN
(ZFK-TPH-20) CFSTI: HC $3.00/MF $0.65

Seminar lectures on an introduction to formal scattering theory are presented, and the formal theory is expanded to nuclear reactions. The most simple applications of the expanded theory to deuteron pickup and rearrangement effects is illustrated. NSA

N67-20250* Pittsburgh Univ., Pa. Dept. of Physics.
CHARGE TRANSFER OF N_2^+ AND O_2^+ WITH SODIUM ATOMS
W. R. Henderson, J. E. Mentall, and W. L. Fite 9 Jan. 1967 17 p refs
(Grants NsG-416; NGR-39-011-013; DA-ARO(D)-31-124-G780)
(NASA-CR-82858; SRCC-38) CFSTI: HC $3.00 CSCL 20H

Collisions of nitrogen and oxygen molecular ions with atomic sodium have been examined in a crossed beam experiment in which the ion energy range was from 25 to 200 eV. It was found that charge transfer occurs with cross sections in excess of 10^{-16} cm^2 and that in both cases the energy dependence is that typical of accidental resonance charge transfer. Extrapolation of these cross sections to the thermal energy range suggests that the thermal energy charge transfer rates are about 5×10^{-11} cm^3/sec with N_2^+ and about 8×10^{-11} cm^3/sec for O_2^+. Author

N67-20290# International Centre for Theoretical Physics, Trieste (Italy).
CONSISTENCY PROBLEMS IN AN EXTENDED SCHWINGER-THIRRING-WESS MODEL
P. L. F. Haberler (Ph.D. Thesis–Wien Univ.) Dec. 1966 19 p refs Submitted for Publication
(IC-66-113) CFSTI: HC $3.00/MF $0.65

The solution of a Thirring-Wess model describing the interaction of massless fermions with massive vector particles is extended to the case of fermions with a finite mass. Special care is given to the definition of the conserved current by which the two fields are coupled to each other and all consistency requirements are checked. Also, the contribution to the Green functions is calculated up to the fourth order of coupling constant. Author (ESRO)

N67-20373 Laboratoire de Physique Theorique et des Hautes Energies, Orsay (France).
ELEMENTARY-PARTICLE THEORY OF NUCLEAR BETA DECAY AND MUON CAPTURE
Henry Primakoff Nov. 1966 31 p refs Lectures presented at 2d Tokyo Inst. of Theoret. Phys., 1966
(TH-171) CFSTI: HC $3.00/MF $0.65

The weak interaction matrix elements between the initial and final nuclear states involved are described in terms of form factors characteristic of the nuclei as wholes, the numerical values of these form factors (at the relevant momentum transfers) reflecting the complexity of the internal nuclear structure. Such a treatment is analogous to the customary treatment of the weak and electromagnetic interactions of nucleons in a world where the nucleons are composed in some realistic sense of quarks; in such a world, one could nevertheless describe the weak and electromagnetic properties of nucleons by suitable form factors without any explicit consideration of the quark-composite structure of the nucleons and our approach is clearly analogous to this with the correspondence: nucleon ↔ nucleus and quark ↔ nucleon. Three particular cases are considered: (1) Nuclear beta decay, (2) Nuclear muon capture, and (3) Sum rules in nuclear beta decay.
Author

25 PHYSICS, PLASMA

Includes magnetohydrodynamics. For applications see: 28 Propulsion Systems.

N67-19371# Israel Program for Scientific Translations, Ltd., Jerusalem.
A HIGH-CURRENT PULSED ION SOURCE
M. A. Abroyan and V. L. Komarov *In its* Elec. Instrumentation in High-Energy Phys., Collection of Papers No. 1 1966 p 97–109 refs (See N67-19361 09-23) CFSTI: HC $3.00/MF $0.65

The ion source and measurement apparatus are described, and experimental procedures and results are discussed in detail. Emphasis in the apparatus description is placed on the selection system and the displacement of the plasma emission opening into the region of maximum magnetic field intensity of the ion source apparatus. Among the conclusions are: (1) The cover plate—extracting electrode with grid selection system makes possible stable pulsed ion beams with currents up to 1.5 amp. (2) The possibility of obtaining a focused ion beam with a current of 70 KeV was demonstrated. (3) Further increase of the ion current is possible through increase of size of the source and a corresponding increase of the source operational parameters. (4) The most promising means of obtaining both pulsed and continuous ion beams with a current considerably in excess of 1 amp is by using multijet plasma sources which create a large, dense plasma surface in the selection region.
N.E.N.

N67-19405# Toronto Univ. (Ontario).
PLASMA DYNAMICS
In its Ann. Progr. Rept., 1966 Oct. 1966 p 7–18 *ref* (See N67-19403 09-34)

Brief summaries are presented on current research in plasma dynamics. Studies included the Hall current acceleration of plasma, the use of spectroscopy for plasma diagnostics, the ionization processes behind a strong shock wave in hydrogen, utilization of an electron beam to measure plasma properties, solar differential rotation, and the two-dimensional magnetohydrodynamic boundary layer theory. Also explored was the theory of spherical and cylindrical electrostatic probes in a collisionless Maxwellian plasma at rest. The behavior of free molecule cylindrical Langmuir probes in supersonic flows was investigated and applied to study of blunt body stagnation layer. Also considered was the finite expansion of an inviscid compressible plasma with low conductivity in the presence of a longitudinal magnetic field. Some aspects of satellite plasma dynamics were examined with particular reference to the top-side sounder Alouette.
S.P.

N67-19456# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
INFLUENCE OF KINETICS OF ELEMENTARY PROCESSES ON IONIZATION OF LOW-TEMPERATURE PLASMA JETS WITH VARIOUS LAWS OF DISTRIBUTION OF PARAMETERS IN THE JETS
N. I. Yushchenkova, V. I. Namchenko, and S. A. Lyzhnikov 30 Aug. 1966 20 p refs Transl. into ENGLISH of the Book "Vliyaniye Kinetiki Elementarnykh Protsessov na Ionizatsiyu Struy Nizkotemperaturnoy Plazmy pri Razlichnykh Zakonakh Raspredeleniya Parametrov v Struyakh" Moscow, Izd. Akad. Nauk, 1965 p 1–16 Presented at the 20th Intern. Congr. on Theoret. and Appl. Chem.
(FTD-MT-65-548; TT-67-60313; AD-644074) CFSTI: HC $3.00/MF $0.65

Results are given of calculations of the ionization of supersonic flows of low-temperature plasma, taking into account kinetics of elementary processes and laws of supersonic expansion corresponding to conditions of flow in supersonic nozzles and jets.
Author (TAB)

N67-19600# Yale Univ., New Haven, Conn.
NO TITLE Progress Report, 1966
Henry Margenau 1 Jan. 1967 15 p refs
(Contract Nonr-609(51))
(AD-644368) CFSTI: HC $3.00/MF $0.65

A review of research is presented in four categories: (1) generation of second harmonics by spatial inhomogeneities of the charge distribution in plasmas, (2) divergences in the statistical theory of radiation in plasmas, (3) conductivity of a fully ionized plasma, and (4) bremsstrahlung and conductivity of a relativistic plasma.
TAB

N67-19520# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
INVESTIGATION OF AN ELECTRODELESS RING DISCHARGE IN ARGON AND IN AIR
I. T. Alad'yev, I. G. Kulakov, O. L. Magdagiyev, and A. P. Shatilov 30 Jun. 1966 20 p refs Transl. into ENGLISH of the paper "Issledovaniye Bezelektrodnogo Kol'tsevogo Razryada v Argone i v Bozdukhe" Presented at the Intern. Symp. on the Properties and Use of Low-Temp. Plasma, Moscow, 1965
(FTD-MT-65-549; TT-67-60289; AD-644005) CFSTI: HC $3.00/MF $0.65

The work describes electrodeless ring discharges in argon and in air obtained in a cylindrical chamber with diameter of 60 mm at a frequency of 2 Mc. There are obtained stable discharges in the range of pressures of 0.4 mm Hg-1 atm in a closed pipe without hydrodynamic stabilization. There are given values of power absorbed by the discharge. For a stabilized discharge in argon at atmospheric pressure there is measured the power absorbed by the discharge and power dissipated on the walls of the chamber at three values of flow rate of gas. There is performed an appraisal of the efficiency of heating of gas in the electrodeless discharge. For certain regimes of a stabilized discharge in argon at atmospheric pressure, the maximum temperature in the discharge and concentration of electrons are measured by the spectral method.
Author (TAB)

N67-19629 Atomic Energy Commission, Oak Ridge, Tenn. Div. of Technical Information Extension.
NUCLEAR FUSION Selected Articles
1966 76 p refs Transl. into ENGLISH from Nucl. Fusion, v. 6, no. 2, 1966 p 93–100 and 118–129
(AEC-TR-6674) CFSTI: HC $3.00

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2. STABILITY OF FLUTE OSCILLATIONS WITH WAVE-PLASMA RESONANCES A. V. Timofeev p 24–44 refs (See N67-19531 09-25)

3. OSCILLATIONS OF A PLASMA BEAM IN A HIGH-FREQUENCY ELECTRIC FIELD L. M. Gorbunov and V. P. Silin p 45–55 refs (See N67-19532 09-25)

4. DIFFUSION PERPENDICULAR TO THE MAGNETIC FIELD IN THE "UNIVERSAL" INSTABILITY N. S. Buchel'nikova p 56–74 refs (See N67-19533 09-25)

N67-19530 Commissariat a l'Energie Atomique, Fontenay-Aux-Roses (France).

EFFICIENCIES FOR PLASMA JET COLLISIONS IN A HOMOGENEOUS MAGNETIC FIELD

P. Evrard, J. Jacquinot, C. Leloup, J. P. Poffe, and F. Waelbroeck *In* AEC Nucl. Fission 1966 p 1–23 refs (See N67-19529 09-25) CFSTI: HC $3.00

Collisions of plasma puffs, whose characteristics vary considerably, are studied in a homogeneous longitudinal magnetic field. It is verified that the puffs meet head on. Collisions of dense and relatively slow puffs are "efficient," that is the initial kinetic energies of the puffs are converted into thermal energy of the ions in the resulting plasma. Faster and less dense puffs interact little. The limit between efficient and inefficient collision corresponds to that which is expected from the test particle model. The slowing down of our puffs is thus ensured mainly by ion-ion interactions. The use of electric probes and the examination of the evolution of the plasma produced by collision show that this plasma does not exhibit any rapid radial motion. Author

N67-19531 Academy of Sciences (USSR), Moscow.

STABILITY OF FLUTE OSCILLATIONS WITH WAVE-PLASMA RESONANCES

A. V. Timofeev *In* AEC Nucl. Fission 1966 p 24–44 refs (See N67-19529 09-25) CFSTI: HC $3.00

The flute oscillations of a hot-ion plasma in a nonuniform magnetic field are discussed. It is shown that resonances, at which the phase velocity of the waves is the same as the velocity of the Larmor ion drift, can have a stabilizing effect. In particular, with careful selection of the resonance characteristics, one can control the most dangerous "model" of the flute oscillations. Also examined are resonances of the second type, which appear only in an electric field; at them the phase velocity of the wave is the same as the velocity of the plasma electric drift. In the presence of such resonances, and natural frequencies of the flute oscillations become complex of necessity and, accordingly, the oscillations themselves either grow or are damped. Author

N67-19532 Academy of Sciences (USSR), Moscow.

OSCILLATIONS OF A PLASMA BEAM IN A HIGH-FREQUENCY ELECTRIC FIELD

L. M. Gorbunov and V. P. Silin *In* AEC Nucl. Fission 1966 p 45–55 refs (See N67-19529 09-25) CFSTI: HC $3.00

Potential oscillations are considered in a system consisting of a neutral and completely ionized plasma and a neutral beam of charged particles in a high-frequency electric field. Under certain conditions, the uniform external high-frequency field leads to a broadening of the instability region and to an increase of the growth rate. Author

N67-19533 Academy of Sciences (USSR), Moscow.

DIFFUSION PERPENDICULAR TO THE MAGNETIC FIELD IN THE "UNIVERSAL" INSTABILITY

N. S. Buchel'nikova *In* AEC Nucl. Fission 1966 p 56–74 refs (See N67-19529 09-25) CFSTI: HC $3.00

Diffusion perpendicular to the magnetic field is investigated in a potassium plasma of nonuniform density in which the "universal" instability is excited. A qualitative picture of such diffusion is obtained by studying the relationship between the radial distribution of plasma density and the magnetic field, and by comparing the experimental densities with ones calculated on the assumption of classical diffusion. The experiments described show that in the low density region the diffusion coefficient is independent both of the magnetic field and of the density, and that it is virtually the same at any distance from the heater. The conclusion is drawn that the diffusion coefficient measured in the density range 10^{9}–10^{10} cm^{-3} is the result of the universal instability in a collisionless plasma. A.G.O.

N67-19750# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

A DYNAMIC THERMOCOUPLE FOR MEASUREMENT OF PLASMA TEMPERATURE TO 4000°C [DINAMICHESKAYA TERMOPARA DLYA IZMERENIYA TEMPERATUR PLAZMY DO 4000°C]

V. Bzhozovski, Sh. Sukerer, and G. Yendzheyets 26 Apr. 1966 20 p refs Transl. into ENGLISH of a paper presented at the Intern. Symp. on the Properties and Use of Low-Temp. Plasma, Moscow, 1965

(FTD-MT-65-528; TT-67-60174; AD-643375) CFSTI: HC $3.00/MF $0.65

In this work there is described a method of measurement of high temperatures of gas (3000 to 4000C) with the help of a Pt - Pt/10% Rh thermocouple introduced into the investigated region in a pulsed manner. In the article there is described a device for dynamic introduction of thermocouple into investigated region together with a time analyzer of the heating curve of the thermocouple. The method is based on measurement of heating of thermocouple in an interval of time smaller than the time necessary for its fusion. There are proposed semi-empirical formulas connected according to known measured temperatures of gas in a furnace (less than 1500C). There was measured temperature of plasma of an acetylene-oxygen burner. Data will agree with the real temperature. Basic measurements were conducted in a flow of combustion products obtained in a combustion chamber; there also were made preliminary measurements in a high-speed plasma tunnel. TAB

N67-19772# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

KINETIC DESCRIPTION OF A RAREFIED FULLY IONIZED PLASMA

A. M. Dyukalov 29 Aug. 1966 22 p refs Transl. into ENGLISH from Zh. Prikl. Mekhan. i Tekhn. Fiz. (Moscow), no. 6, 1964 p 39–49

(FTD-HT-66-399; AD-643901) CFSTI: HC $3.00/MF $0.65

The Vlasov system of equations is usually used to describe a rarefied plasma. The method of constructing these solutions for application to the simplest flat case is generalized below for a wide class of problems, which are conveniently characterized as problems with emitting surfaces. Author (TAB)

N67-19801# Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

STUDY OF EXCITED STATES OF MOLECULAR OXYGEN BY MOLECULAR BEAM MAGNETIC RESONANCE TECHNIQUES

Gilbert O. Brink Nov. 1966 49 p refs
(Contract DA-49-146-XZ-483)
(CAL-RM-2156-P-1; AD-643526) CFSTI: HC $3.00/MF $0.65

The purpose of this program is to investigate the effect of metastable excited states of atoms and molecules on chemical reactions that are of importance in the upper atmosphere. The majority of laboratory studies of these reactions use flowing afterglow systems in which reactive species are produced in a discharge and then allowed to react with other species in a flowing afterglow. Since these systems are usually monitored optically, it is difficult to obtain information concerning long-lived excited species directly. Many of these species contain significant energy of excitation which can alter their chemical properties markedly as compared with those of their ground states. It is desirable, therefore, to have available an experimental technique that would allow a direct assessment of the importance of these metastable states. Such a technique is that of molecular beam magnetic resonance, which permits a direct sampling of the metastable states present in the reaction system. Its preliminary application to this problem is discussed in this report. TAB

N67-19817# Northwestern Univ., Evanston, Ill. Gas Dynamics Lab.
MEASURED INDEX OF REFRACTION OF AN ARGON PLASMA Final Technical Report
W. F. Hug, D. L. Evans, R. S. Tankin, and A. B. Cambel Jul. 1966 58 p refs
(Contract AF 33(615)-1160)
(ARL-66-0140; AD-643077) CFSTI: HC $3.00/MF $0.65

The index of refraction for argon over a temperature range of 10,000K to 18,000K is measured at a wavelength of 6328A. A helium-neon laser is used as a light source for a Mach-Zehnder interferometer in these experiments. A commercially made plasma torch which was modified, was used to produce the plasma jet discharging into the atmosphere. The measured index of refraction lies between the curve representing the calculated ground state and free electron contributions and the curve representing the excited electron as a free electron. Author (TAB)

N67-19934* Maryland Univ., College Park.
COMPUTER PROGRAMS FOR THE CALCULATION OF EQUILIBRIUM STATES IN REFLECTED SHOCK PLASMAS
David W. Koopman Nov. 1966 58 p refs
(Grant NsG-359)
(NASA-CR-82931; BN-481) CFSTI: HC $3.00 CSCL 20H

Procedures have been developed for the calculation of the states attained behind incident and reflected shocks in fully dissociating and partially ionizing gases initially composed of a mixture of molecular species. Ideal shock tube flow conditions are assumed; the calculations include the effects of temperature dependent partition functions, lowered ionization potentials, and simultaneous ionization of a number of atomic species in several ionization stages. The calculation has been programmed in the MAD computer language and applied to shocks in neon containing additives, with reflected region temperatures in the 8,000°K–14,000°K range. The theoretical background of the calculations, as well as the programs and results, are presented; programs for the calculation of equilibrium conditions, given pressure (or electron density) and temperature, are also presented. Author

N67-19949*# Catholic Univ. of America, Washington, D. C. Dept. of Space Science and Applied Physics.
DIAGNOSTICS OF ACCELERATING PLASMA Semiannual Progress Report, 1 Sep. 1966–28 Feb. 1967
T. N. Lie, A. W. Ali, E. A. McLean, and C. C. Chang 28 Feb. 1967 44 p refs
(Grant NGR-09-005-025)
(NASA-CR-82950; Rept.-66-201; SAPR-2) CFSTI: HC $3.00/MF $0.65 CSCL 20I

The radial electron density distributions, the electron temperatures, and the shapes of the current sheets produced in coaxial plasma accelerators of different radius ratio were determined using fast photography and spectroscopic techniques. Pronounced polarity effect in these accelerators were observed for most of the working gases. However, in the case of hydrogen the polarity dependent behavior is much less noticeable. Present experimental methods were extended to the discharge plasma produced in a parallel plate plasma accelerator in an attempt to gain better understanding on the current sheet behavior. Since some of the spectroscopic techniques used or to be used in the investigation depend on the assumption of local thermal equilibrium, the validity of LTE in the plasma under interest was studied and its theoretical result is given. Author

N67-20152# Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires.
SIMULTANEOUS EXCITEMENT OF ELECTRON AND ION RESONANCES IN A MAGNETOPLASMA BY A HIGH FREQUENCY ELECTROMAGNETIC FIELD LOW FREQUENCY MODULATED [EXCITATION SIMULTANEE DES RESONANCES ELECTRONIQUE ET IONIQUE DANS UN PLASMA DANS UN CHAMP MAGNETIQUE STATIQUE, PRODUITE PAR UN CHAMP ELECTROMAGNETIQUE H. F. MODULE A UNE BASSE FREQUENCE]
Enrico Zilli Jul. 1966 46 p refs In FRENCH
(CEA-R-3053; Rept.-450) CFSTI: HC $3.00/MF $0.65

A single particle, collisionless, nonrelativistic theory is exposed, in which the possibility is shown of exciting electron and ion resonances in a magnetoplasma, by means of a high frequency electromagnetic field, whose amplitude is low frequency modulated. Two solutions of this problem are given. The first one rests on the possibility of exciting the ion cyclotron resonance taking into account the low frequency electromagnetic field, low frequency modulated. In the second solution the possibility of exciting the electron and ion resonances is considered in an electromagnetic field, whose magnetic component parallel to $\overline{B}_0$ is low frequency modulated. The results are discussed in the field of a cylindrical waveguide driven in the TE_{01} mode, B_0 being parrallel to the axis. Author (NSA)

N67-20186# Illinois Univ., Urbana. Gaseous Electronics Lab.
INVESTIGATIONS OF BASIC PROPERTIES OF GASEOUS PLASMAS Final Report, 1 Aug. 1963–31 Jul. 1966
L. Goldstein Oct. 1966 12 p refs
(Contract AF 19(628)-3307)
(AFCRL-66-752; AD-643768) CFSTI: HC $3.00/MF $0.65

The report briefly reviews the original purposes of the investigations, the results obtained, and lists the technical reports and the scientific journal articles in which the results of the investigations have been published. Author (TAB)

N67-20195# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
WAVE GUIDE PROPERTIES OF A GAS-ELECTRON BEAM SYSTEM
V. B. Krasovyts'kyy 27 Jun. 1966 8 p refs Transl. into ENGLISH from Ukr. Fiz. Zh. (Kiev), v. 9, no. 6, 1964 p 692–693
(FTD-HT-66-172; AD-644015) CFSTI: HC $3.00/MF $0.65

Utilizing the great stresses of an electric field, which exist in focused light beams, for the acceleration of charged particles

requires an examination of the system in which slow light waves can be realized. In this report one of the variants of such a system was investigated, namely: an electron beam, which passes through oscillator gases. TAB

N67-20221*# National Aeronautics and Space Administration, Washington, D. C.
HIGH FREQUENCY PROPERTIES OF PLASMA
K. D. Sinel'nikov, ed. Mar. 1967 250 p refs Transl. into ENGLISH from the Book "Vysokochastotnyye Svoystva Plazmy" Kiev, Izd. Akad. Nauk SSR, 1965
(NASA-TT-F-449) CFSTI: $3.00 CSCL 20I

Reports on high frequency plasma heating, linear plasma oscillations, plasma nonlinear oscillations and wave interaction, and excitation of plasma oscillations are presented. For individual titles see N67-20222–N67-20246.

N67-20222*# National Aeronautics and Space Administration, Washington, D. C.
INVESTIGATION OF THE ENERGY OF CHARGED PARTICLES EMANATING FROM A MAGNETIC TRAP DURING HIGH FREQUENCY HEATING
N. I. Nazarov, A. I. Yermakov, and V. T. Tolok *In its* High Frequency Properties of Plasma Mar. 1967 p 1–6 refs (See N67-20221 09-25) CFSTI: $3.00

Reviewed are technical results derived from measuring the energy of ions and electrons passing along the magnetic field, when ion cyclotron and rapid magnetohydrodynamic waves are employed for heating the plasma. The plasma electron temperature was determined by a spectral method, and the energy of charged particles measured by a transit time electrostatic analyzer and a multigrid probe. The results derived from measuring the ion energy spectrum by means of the multi-grid probe confirmed the results obtained with analyzer measurements. The proton energy spectrum maximum was in the region of 2 keV when the plasma was heated with ion cyclotron waves. The electron energy remained low, and amounted to 30 eV in all. This result also coincides closely with the results derived from measuring the electron energy by the spectral methods. The measurements of the energy spectrum of ions and electrons by the multigrid probe, when the plasma was heated with a rapid magnetosound wave, showed that the electron and ion energies were approximately the same (150 eV). The ion energies obtained by measurements with the probe and the analyzer also coincided fairly well. R.Ll.

N67-20223*# National Aeronautics and Space Administration, Washington, D. C.
MEASUREMENT OF THE PERPENDICULAR ENERGY COMPONENT AND THE PLASMA DECAY TIME DURING HIGH FREQUENCY HEATING
N. I. Nazarov, A. I. Yermakov, and V. T. Tolok *In its* High Frequency Properties of Plasma Mar. 1967 p 6–10 refs (See N67-20221 09-25) CFSTI: $3.00

In an investigation of the effectiveness of plasma heating, the technique for the measurement of charged particle temperature is reviewed. Summary data analyzed from the experiments reviewed lead to the conclusion that a plasma may be heated to a temperature exceeding 1 keV by means of resonance excitation of an ion cyclotron wave. The limiting value T_i is determined by the apparatus parameters. In addition, the results obtained provide a basis for assuming that–when a hot plasma is insulated from the chamber walls by vacuum interstratification–the time the plasma may be contained may be increased considerably, under the condition that there are no other loss mechanisms. R.Ll.

N67-20224*# National Aeronautics and Space Administration, Washington, D. C.
HIGH FREQUENCY ENERGY ABSORPTION BY A PLASMA IN ION CYCLOTRON RESONANCE IN STRONG, HIGH FREQUENCY FIELDS
V. V. Chechkin, M. P. Vasil'yev, L. I. Grigor'yeva, and B. I. Smerdov *In its* High Frequency Properties Plasma Mar. 1967 p 11–21 refs (See N67-20221 09-25) CFSTI: $3.00

Reviewed are studies on high frequency energy absorption by a plasma in ion cyclotron resonance. It was found that the value obtained experimentally for the effective frequency of ion collisions, and also the diffusion coefficient determined according to the plasma decay time, coincide in order of magnitude with the corresponding values calculated according to the theory of ion cyclotron wave stability. Consideration is also briefly given to the question of turbulent plasma heating in ion cyclotron resonance. This heating period is thought to be quite small, so that anomalous diffusion caused by plasma instability does not produce significant losses in plasma particles. R.Ll.

N67-20225*# National Aeronautics and Space Administration, Washington, D. C.
INVESTIGATION OF CONDITIONS PRODUCING A DENSE PLASMA IN A METALLIC CHAMBER AND ITS HIGH FREQUENCY HEATING
O. M. Shvets, S. S. Ovchinnikov, V. F. Tarasenko, L. V. Brzhechko, O. S. Pavlichenko et al *In its* High Frequency Properties of Plasma Mar. 1967 p 22–33 refs (See N67-20221 09-25) CFSTI: $3.00

Experimental results on high frequency oscillators, employed to produce a dense plasma in a metallic chamber, are reviewed, and a determination made of the main plasma parameters. Next studied was the possible heating of ions by generating ion cyclotron waves in a dense plasma produced by a high frequency (hf) oscillator in a metallic discharge chamber. In certain operational regimes of the experimental apparatus, generation of a rapid magnetosound wave, at a magnetic field strength less than the cyclotron value for protrons, was observed. However, conditions were not considered favorable for studying it at the existing oscillator frequency ($1.82 \cdot 10^6$ cps). The experiments described probably illustrate the feasibility of high frequency heating of a dense plasma consisting of two types of ions by resonance generation of ion cyclotron waves for one type of ions. R.Ll.

N67-20226*# National Aeronautics and Space Administration, Washington, D. C.
HIGH FREQUENCY PLASMA HEATING
K. N. Stepanov *In its* High Frequency Properties of Plasma Mar. 1967 p 33–54 refs (See N67-20221 09-25) CFSTI: $3.00

Various methods of high frequency plasma heating are reviewed. By the ohmic method employed to heat a plasma by a constant electric field with strength E, the electron energy increase is determined. Investigated was the Cherenkov absorption by plasma ions of the energy of an electromagnetic field produced by azimuthal electric currents. Equations are presented on Cherenkov electron heating by the field of a magnetosound wave (helicon). It was found that Cherenkov and cyclotron plasma heating with weak fields occur at the same rate as ohmic heating by a constant electric field, and that plasma heating by weak fields up to thermonuclear temperatures takes place over a long period of time. R.Ll.

N67-20227*# National Aeronautics and Space Administration, Washington, D. C.
DIELECTRIC CONSTANT OF A PLASMA IN A DIRECT PINCH MAGNETIC FIELD AND IN A DIRECT HELICAL MAGNETIC FIELD

V. F. Aleksin and V. I. Yashin *In its* High Frequency Properties of Plasma Mar. 1967 p 55–63 refs (See N67-20221 09-25) CFSTI: $3.00

In an investigation of the problem of controlled thermonuclear synthesis, the dielectric constant of a plasma both in a direct pinch magnetic field, and in a direct helical magnetic field are of a stellarator are reviewed. Mathematical expressions are derived to study the electromagnetic oscillations and plasma stability both fields. R.Ll.

N67-20228*# National Aeronautics and Space Administration, Washington, D. C.

KINETIC THEORY OF ELECTROMAGNETIC WAVES IN A CONFINED PLASMA

A. N. Kondratenko *In its* High Frequency Properties of Plasma Mar. 1967 p 64–74 refs (See N67-20221 09-25) CFSTI: $3.00

For possible application to methods of plasma heating, acceleration of charged particles, plasma diagnostics, electromagnetic wave propagation in a confined plasma was studied. Maxwell equations and a dispersion equation were derived in the formulation of the problem. Plasma ions, contributing to the damping for a surface ion-sound wave, were considered as were the damping decrements of a surface ion-sound wave. It is stated that plasma ions make a significant contribution to the damping. The wave phase velocity is decreased with a decrease in the layer thickness; therefore, the ion contribution to the damping increases, while the electron contribution decreases. R.Ll.

N67-20229*# National Aeronautics and Space Administration, Washington, D. C.

KINETIC THEORY OF A SURFACE WAVE IN A PLASMA WAVE GUIDE

M. F. Gorbatenko and V. I. Kurilko *In its* High Frequency Properties of Plasma Mar. 1967 p 75–80 refs (See N67-20221 09-25) CFSTI: $3.00

In the case of small thermal velocities, where the damping coefficient is proportional to the thermal velocity of plasma electrons, a plasma wave guide produced by a plasma layer having a finite thickness was investigated. It is assumed that the equilibrium distribution function is a Maxwell distribution, and the initial system of equations derived consists of the kinetic equation for a high frequency addition to the distribution function and of a Maxwell equation. It was found that in the case of a plasma layer having a finite thickness, the surface wave damping is proportional to V_T. However, the wave damping increases with a decrease in the layer thickness, because the wave phase velocity decreases. R.Ll.

N67-20230*# National Aeronautics and Space Administration, Washington, D. C.

SINGULARITIES OF AN ELECTROMAGNETIC FIELD IN A NONUNIFORM, MAGNETOACTIVE PLASMA

V. V. Dolgopolov *In its* High Frequency Properties of Plasma Mar. 1967 p 80–89 refs (See N67-20221 09-25) CFSTI: $3.00

Investigated is the behavior of the electric field of an inflated wave close to the inflation point in a magnetoactive plasma both for the case of an arbitrary angle between the direction of the constant magnetic field and the normal to the plasma layer surface, and for the case of oblique wave incidence on the layer. A solution is found over a wider region for certain special cases for a wavelength which is little less than the distance at which the layer parameters change significantly. After analysis, it was found that it is not advantageous to employ inflated fields for plasma heating. R.Ll.

N67-20231*# National Aeronautics and Space Administration, Washington, D. C.

EXCITATION OF A MAGNETOHYDRODYNAMIC WAVE GUIDE IN A COAXIAL LINE

S. S. Kalmykova and V. I. Kurilko *In its* High Frequency Properties of Plasma Mar. 1967 p 89–91 refs (See N67-20221 09-25) CFSTI: $3.00

A special case of excitation is investigated in relation to matching between an anisotropic dielectric wave guide and a coaxial line. Mathematical expressions are derived for the diffracted magnetic field, magnetic field amplitude, and stray field of large plasma density. The effective excitation of magnetohydrodynamic waves by a coaxial line is observed only for strong magnetic fields. It was found that harmonics with large numbers corresponding to the limiting case specified are always only slightly excited. For weak magnetic fields, the main portion of the coaxial wave power is dispersed into excitation of the surface plasma wave. R.Ll.

N67-20232*# National Aeronautics and Space Administration, Washington, D. C.

THEORY OF MAGNETOHYDRODYNAMIC WAVE SCATTERING AT THE END OF A WAVE GUIDE

V. I. Kurilko *In its* High Frequency Properties of Plasma Mar. 1967 p 91–100 refs (See N67-20221 09-25) CFSTI: $3.00

For the theory of magnetohydrodynamic wave scattering, the phenomena for a semi-infinite plasma wave guide is studied. In the general case, this problem may be reduced to a system of two coupled integral equations or (in the presence of an infinite casing) to two infinite, coupled systems of algebraic equations, whose solution may be found only by numerical methods. From the mathematical formulas derived, it is seen that the coefficients of the inter-transformation of the magnetohydrodynamic waves decrease with an increase in the wave number and a decrease in the magnetic field strength. If the plasma wave guide is surrounded by a conducting casing, it is impossible to study magnetohydrodynamic waves under certain conditions, and only the transformation of one oscillation into another occurs at the end of the wave guide. R.Ll.

N67-20233*# National Aeronautics and Space Administration, Washington, D. C.

DETERMINATION OF PLASMA TEMPERATURE AND DENSITY DISTRIBUTION BY REFRACTION AND DAMPING OF A BEAM

V. L. Sizonenko and K. N. Stepanov *In its* High Frequency Properties of Plasma Mar. 1967 p 100–109 refs (See N67-20221 09-25) CFSTI: $3.00

Two methods are reviewed for determining plasma electron temperature and density distribution. By changing the angle of incidence of a beam through a nonuniform plasma, or the frequency of the microwave signal, the plasma density distribution can be determined by the beam refraction, and the plasma electron temperature distribution determined by the damping of the wave energy along the beam. A mathematical expression is derived to determine beam trajectory in a plasma, and this is applied to the inverse problem. The plasma density distribution $n(r)$ may be found from the specific experimental dependence of the angle at which the beam leaves the plasma on the angle of incidence. The density distribution along the cylinder axis in the case of axial symmetry is considered. Also found is the dependence of the damping coefficient on the radius according to the specific dependence of damping on the angle of incidence. R.Ll.

N67-20234*# National Aeronautics and Space Administration, Washington, D. C.

EXCHANGE OF ENERGY BETWEEN HIGH FREQUENCY AND LOW FREQUENCY OSCILLATIONS IN A PLASMA

V. D. Fedorchenko, V. I. Muratov, and B. N. Rutkevich *In its* High Frequency Properties of Plasma Mar. 1967 p 110–119 refs (See N67-20221 09-25) CFSTI: $3.00

The relationship between high and low frequency oscillations in a plasma is reviewed in the light of the effective exchange of energy. Frequency oscillation interactions were observed when the frequency of the outer signal did not coincide with any of the plasma eigen frequencies, when it coincided with the electron cyclotron frequency, and when it coincided with the plasma electron frequency. Since low frequency oscillations represent ion motion (which is transverse with respect to the bundle) in the field of the space charge of electrons contained by a magnetic field, the effective transfer of energy from electron plasma oscillations to ion oscillations is indicated. R.Ll.

N67-20235*# National Aeronautics and Space Administration, Washington, D. C.

DISSIPATION OF PLASMA OSCILLATIONS EXCITED IN A CURRENT-CARRYING PLASMA

Ye. A. Sukhomlin, V. A. Suprunenko, N. I. Reva, and V. T. Tolok *In its* High Frequency Properties of Plasma Mar. 1967 p 119–126 refs (See N67-20221 09-25) CFSTI: $3.00

The heating and containment of a plasma in a strong magnetic field, under conditions when bunched instabilities excited by escaping electrons develop in the plasma, were investigated. The experiments were performed on a rectilinear tube apparatus, usually filled with hydrogen, with aluminum electrodes at each end of the tube. A battery of capacitors with an overall capacitance of 15 microfarads was discharged between the electrodes. During the first half-period of discharge, a highly ionized plasma filament was produced. The plasma density changed between 10^{14}–10^{13}cm^{-3}. Oscillograms depicting 1) microwave radiation from the plasma, 2) overall discharge current, 3) current of escaping electrons, and 4) the voltage between the electrodes of the discharge tube reduced to a single time scale, are presented. Other observations are also noted and discussed. The data indicate that X-ray radiation from discharge is related to the thermalization of bunched instability energy. R.Ll.

N67-20236*# National Aeronautics and Space Administration, Washington, D. C.

DAMPING OF INITIAL PERTURBATION AND STEADY FLUCTUATIONS IN A COLLISIONLESS PLASMA

A. I. Akhiyezer, I. A. Akhiyezer, and R. V. Polovin *In its* High Frequency Properties of Plasma Mar. 1967 p 127–132 refs (See N67-20221 09-25) CFSTI: $3.00

The mechanism for establishing fluctuations, (which are not dependent on the initial perturbations, of the macroscopic quantities in a nonequilibrium plasma, are investigated. It is shown that the fluctuations are established due to the survival of a singular component in the mathematical expression for the distribution function perturbation. The derivation presented makes it possible to determine the time required to establish the fluctuations. L.S.

N67-20237*# National Aeronautics and Space Administration, Washington, D. C.

CHARGED PARTICLE INTERACTION WITH A TURBULENT PLASMA

I. A. Akhiyezer *In its* High Frequency Properties of Plasma Mar. 1967 p 133–136 refs (See N67-20221 09-25) CFSTI: $3.00

The energy lost (or acquired) per unit of time by a charged particle when moving through a turbulent plasma is computed. The dependence of the particle energy change on the magnitude and direction of its velocity is established in explicit form. It is shown that the turbulence spectrum elements have no influence on this dependence. The strength of charged particle interaction with the plasma is determined by the level of plasma fluctuations. In particular, the particle energy losses per unit of time P are related to the charge density correlator by a relationship which is given. Author

N67-20238*# National Aeronautics and Space Administration, Washington, D. C.

THEORY OF NONLINEAR MOTIONS OF A NONEQUILIBRIUM PLASMA

I. A. Akhyezer *In its* High Frequency Properties of Plasma Mar. 1967 p 136–142 refs (See N67-20221 09-25) CFSTI: $3.00

The moments of a distribution function are introduced into a system of equations describing the motion of a collisionless plasma consisting of hot electrons and cold ions to obtain a new equation system more advantageous than the initial system. The new system includes terms which are only dependent on x and t, while the initial system also includes the electron velocity distributions. The initial system of equations is also rewritten in other reduced forms to obtain other aspects of a perturbation having a finite amplitude (such as the direction of change of quantities characterizing the plasma, including the electron distribution function). L.S.

N67-20239*# National Aeronautics and Space Administration, Washington, D. C.

NONLINEAR PROCESSES IN A UNIFORM AND ONE-COMPONENT PLASMA

N. A. Khizhnyak and A. M. Korsunskiy *In its* High Frequency Properties of Plasma Mar. 1967 p 143–150 refs (See N67-20221 09-25) CFSTI: $3.00

The more general nonlinear solutions of a one-dimensional kinetic equation without collisions are investigated. In the case cited, the main plasma characteristics may be compiled within the framework of a hydrodynamic approximation, and the electron velocity distribution function may be found rather simply. A mathematical expression is derived to find the electron plasma density from the specific wave velocity and the hydrodynamic velocity. Consideration is also given to the propagation of waves in media with linear dispersion. The electron velocity distribution function is stated for the case of a square dispersion law. The relationships obtained in this brief mathematical exposition permit a study to be made of the collisionless transition of electrons from the region of trapped particles into other plasma electrons and the associated energy distribution. R.Ll.

N67-20240*# National Aeronautics and Space Administration, Washington, D. C.

INDUCED SCATTERING OF LANGMUIR OSCILLATIONS IN A PLASMA LOCATED IN A STRONG MAGNETIC FIELD

V. D. Shapiro and V. I. Shevchenko *In its* High Frequency Properties of Plasma Mar. 1965 p 151–158 refs (See N67-20221 09-25) CFSTI: $3.00

Investigations were conducted on the nonlinear interaction of harmonics in the long wave spectral region of Langmuir oscillations ($k\gamma_{De} << 1$). The linear damping of these oscillations, which is caused by the interaction with resonance particles, is negligibly small. It is assumed that the plasma is located in a rather strong magnetic field, so that the plasma particle oscillations are possible only in the direction of the magnetic field which is parallel to oz. Author

N67-20241*# National Aeronautics and Space Administration, Washington, D. C.

NONLINEAR THEORY OF LOW FREQUENCY OSCILLATIONS EXCITED BY AN ION BUNDLE IN A PLASMA

D. G. Lominadze and V. I. Shevchenko *In its* High Frequency Properties of Plasma Mar. 1967 p 159–172 refs (See N67-20221 09-25) CFSTI: $3.00

The initial or hydrodynamic stage of instability development is examined. In this stage, the bundle remains monoenergetic and the instability develops very rapidly. The most unstable oscillation branches which produce the dynamics of the development are found, and the change in the macroscopic parameters of the bundle and the plasma is determined. The excitation of long wave, low frequency oscillations is considered, and equations are formulated. It is shown that the plasma electron distribution function changes most rapidly in the resonance region, with a plateau appearing in the velocity range in which oscillations are excited at a given moment of time. A change in the spectral density of oscillations and ion parameters occurs more slowly. Under these conditions, the electrons have no significant influence on the dynamics of instability development. In a strong magnetic field, instability development is traced at the quasi-linear stage, and the state at which the bundle and the plasma arrive, due to the quasi-linear relaxation process, is determined. M.G.J.

N67-20242*# National Aeronautics and Space Administration, Washington, D. C.

NONLINEAR PHENOMENA IN A PLASMA WAVE GUIDE (ION CYCLOTRON RESONANCE AT A DIFFERENCE FREQUENCY)

B. I. Ivanov *In its* High Frequency Properties of Plasma Mar. 1967 p 172–179 refs (See N67-20221 09-25)

Details are given on the model apparatus which was designed to study the mechanism by which low frequency oscillations are excited close to the ion cyclotron frequency. Low power generators, which have a relatively small disturbing influence on the independently-produced plasma, were used. To fulfill the nonlinearity condition, operations were conducted at low frequencies and low phase velocities; a low density plasma was employed. The necessary condition for observing the ion cyclotron resonance at the difference frequency is formulated. Based on the measurements obtained, it is concluded: (1) At the moment that resonance is passed, the amplitude of the difference wave increased. (2) The resonance frequency increased with an increase in the magnetic field strength, and decreased with an increase in plasma density. (3) Observations correspond qualitatively to the excitation of ion cyclotron waves at the difference frequency. Experimental data also agree qualitatively with the dispersion relationship for ion cyclotron waves. M.G.J.

N67-20243*# National Aeronautics and Space Administration, Washington, D. C.

RADIATION OF ELECTRONS IN THE PLASMA-MAGNETIC FIELD BOUNDARY LAYER

V. V. Dolgopolov, V. I. Pakhomov, and K. N. Stepanov *In its* High Frequency Properties of Plasma Mar. 1967 p 180–183 refs (See N67-20221 09-25)

The intensity of cyclotron radiation is determined, based on the assumption that the radiated waves correspond to stable plasma oscillations. In the case of radiation equilibrium, the radiation flux falling on the plasma–magnetic field boundary equals the sum of the flux emanating from the plasma and the flux reflected from the plasma. The width of the radiation spectrum, caused by the Doppler effect during radiation and by the nonuniformity of the magnetic field in the boundary layer, is also considered. The total intensity of electron cyclotron radiation in the layer is formulated. Equations are also given for the absorption of waves whose electric vector lies in the plane of incidence, and who impact on the plasma layer from a vacuum. M.G.J.

N67-20244*# National Aeronautics and Space Administration, Washington, D. C.

RADIATION OF LOW FREQUENCY WAVES BY IONS AND ELECTRONS OF A NON-ISOTHERMIC MAGNETOACTIVE PLASMA

V. I. Pakhomov *In its* High Frequency Properties of Plasma Mar. 1967 p 183–198 refs (See N67-20221 09-25)

Expressions are determined for the intensities of radiation of Alfvén, rapid, and slow magnetosound waves by ions and electrons. Each of these waves may be excited due to ion cyclotron radiation or to Cerenkov radiation of ions and electrons moving along a spiral in the plasma. First, general expressions are employed to derive the dielectric constant tensor of a nonisothermic plasma located in the outer magnetic field. Next, a general expression for ion radiation intensity in a nonisothermic plasma is obtained. The cyclotron radiation of a slow magnetosound wave in a low-pressure plasma is investigated, and Cerenkov radiation of magnetohydrodynamic waves by ions is considered. Cerenkov radiation of low frequency waves by electrons of a nonisothermic plasma is studied, because under certain conditions it may make the main contribution to the over-all plasma radiation. S.P.

N67-20245*# National Aeronautics and Space Administration, Washington, D. C.

BRAKING OF RELATIVISTIC PARTICLES IN LOW ATMOSPHERIC LAYERS

V. B. Krasovitskiy and V. I. Kurilko *In its* High Frequency Properties of Plasma Mar. 1967 p 199–202 refs (See N67-20221 09-25)

To investigate the influence of an isotropic dielectric medium on the braking radiation (bremsstrahlung), the total energy losses by radiation as a function of particle energy were determined. For small particle energies, the presence of the medium leads to an increase in the frequency, and the corresponding wavelength decreases. Therefore, the braking radiation intensity, which is proportional, also increases. For large particle energies, the frequency decreases considerably. Correspondingly, the braking radiation intensity decreases. The Cherenkov radiation, which can be computed from the usual formulas in the case under consideration, is larger than the bremsstrahlung throughout the entire energy region where the influence of the medium must be taken into account. R.Ll.

N67-20246*# National Aeronautics and Space Administration, Washington, D. C.

EXCITATION OF WAVES IN A CONFINED PLASMA BY MODULATED CURRENTS

A. N. Kondratenko *In its* High Frequency Properties of Plasma Mar. 1967 p 203–209 refs (See N67-20221 09-25)

Excitation of waves in a confined plasma is studied taking into account its nonlinearity. In solving the problem of wave excitation in a plasma by a modulated current it is assumed that the current is given, and the inverse influence of the wave on the motion of current particles is disregarded. This is valid as long as the energy losses of the current particles at the wave length are negligibly small as compared with the energy itself. The plasma layer that is infinite in two directions and bounded by two parallel metallic plates in a third direction is considered. Two problems are investigated. First the wave field strength is determined in the linear approximation for an arbitrary dispersion law. In the second problem, the wave field strength is determined in the nonlinear by hydrodynamic approximation. S.P.

N67-20277# Kernforschungsanlage, Juelich (West Germany). Institut fuer Plasmaphysik.
INVESTIGATION ON ELECTRODELESS ACCELERATION OF PLASMA FOR THE DEVELOPMENT OF A SPACE PROPULSION SYSTEM [UNTERSUCHUNGEN ZUR ELEKTRODENLOSEN BESCHLEUNIGUNG VON PLASMA FUER DIE ENTWICKLUNG EINES RAUMANTRIEBES]
H. Tuczek Mar. 1966 73 p refs In GERMAN
(JUL-358-PP)

For the development of an electrodeless plasma propulsion installation, the inductive acceleration of plasma in a conical ring discharge, in a pulsed traveling wave, and in a periodic traveling wave was investigated. In the conical ring discharge a current produces in a coil with conical profile a time-changing inhomogeneous magnetic field in which the preheated plasma is accelerated. In the pulsed traveling wave, which leads to a chain guide, the acceleration of an injected plasma occurs in the inhomogeneous magnetic field of the wave front. In the periodic traveling wave, which consists of several attenuated wave trains, the plasma is produced by the wave itself. The results with the conical wave discharge and the pulsed traveling wave show that at densities below 10^{15} cm^{-3}, in which ion collisions do not essentially affect the processes, plasma is effectively accelerated. The acceleration process can be described by a single-particle model with elastic reflection of the ions. Since, according to the measurements, it is possible on periodic traveling waves to produce and accelerate plasma without supplementary preheating, the technological construction of a plasma propulsion system is simplified. From the investigation it was determined that at operational densities of approximately 10^{14} cm^{-3} an electrodeless plasma propulsion installation with thrust up to 1 kp can be developed.
Author (NSA)

N67-20285# International Centre for Theoretical Physics, Trieste (Italy).
EFFECTS OF GEODESIC CURVATURE IN CLOSED CONFIGURATIONS
B. Coppi Jun. 1966 13 p refs Submitted for publication
(IC-66-83) CFSTI: HC $3.00/MF $0.65

The effects on the stability of a plasma toroidal configuration due to the component of the magnetic field curvature lying within the magnetic surface are considered. The analysis is simplified by introducing an appropriate one-dimensional model. Then, recalling that this magnetic curvature component has a periodicity along the field lines with zero average, it is shown that, when the periodicity is shorter than a given amount, no instability localized in a particular region along the field can be found. In this case the stability analysis is reduced to consider modes which extend along the magnetic field and adapt themselves to the periodicity of the curvature. Within this frame, attention is also devoted to modes with arise in the presence of shear when the mentioned periodicity length is relatively large.
Author (ESRO)

N67-20286# International Centre for Theoretical Physics, Trieste (Italy).
COLLISIONLESS SHOCK WAVES IN HIGH β PLASMAS, PART 2
C. F. Kennel (Avco-Everett Res. Lab.) and R. Z. Sagdeev (Inst. of Nucl. Phys.) Jun. 1966 27 p refs Submitted for publication
(IC-66-88) CFSTI: HC $3.00/MF $0.65

Finite Larmor radius effects create dispersion for magnetosonic waves which propagate perpendicular to the magnetic field in high β plasmas. A solitary wave, and with some dissipation a wave train type irreversible shock, can then be constructed in the approximation of low Mach number. Such non-linear magnetosonic waves are unstable to decay into two others, thus providing dissipation and a thinner shock than for parallel propagating shocks. Since magnetic sound waves couple non-linearly, the decay length of the turbulence behind perpendicular shocks could be significantly shorter than behind parallel shocks for which strictly linear Alfven waves provide the dissipation.
Author (ESRO)

N67-20287# International Centre for Theoretical Physics, Trieste (Italy).
COLLISIONLESS SHOCK WAVES IN HIGH β PLASMAS
C. F. Kennel (AVCO-Everett Res. Lab.), and R. Z. Sagdeev (Inst. of Nucl. Phys.) Jun. 1966 27 p refs Submitted for publication
(IC-66-88) CFSTI: HC $3.00/MF $0.65

Compressional large-amplitude waves propagating along the magnetic field direction necessarily destabilize Alfven waves in high β plasmas by the firehose mechanism. When the electron temperature is much larger than the ion temperature, a closed set of fluid equations, including the turbulent Alfven wave dissipation in the quasi-linear approximation, may be constructed. This set, investigated here in the limit of weak shocks propagating along the magnetic field, has shock solutions. Microscopic short wavelength turbulence may also be generated in large amplitude shocks, but will probably not affect the Alfven wave spectrum. The existence of large amplitude and yet-persisting-magnetic field turbulence behind the earth's bow shock is in qualitative agreement with this model.
Author (ESRO)

N67-20288# International Centre for Theoretical Physics, Trieste (Italy).
INSTABILITIES DUE TO TEMPERATURE GRADIENTS IN COMPLEX MAGNETIC FIELD CONFIGURATIONS
B. Coppi, M. N. Rosenbluth, and R. Z. Sagdeev Jul. 1966 20 p refs Submitted for publication
(IC-66-24) CFSTI: HC $3.00/MF $0.65

An integral equation is derived, governing an instability due to ion temperature gradients. In the presence of magnetic shear, localized nonconvective normal modes of instability are shown to exist if the relative temperature gradient is larger than that of density, unless the shear is exceedingly strong, i.e., the field shears through a large angle in the distance in which the temperature drops. Quasi-modes which are less localized in the direction of the gradient can be constructed from these normal modes and a large thermal diffusion may be expected. Conversely the mass diffusion is shown to be rather slow so that it is reasonable to assume that an effective 'divertor' should keep the actual heat loss quite small.
Author (ESRO)

N67-20289# International Centre for Theoretical Physics, Trieste (Italy).
LAMINAR HYDROMAGNETIC WAVES OF FINITE AMPLITUDE IN PLASMAS OF LOW TEMPERATURES
A. Cavaliere and F. Engelmann (EURATOM, Rome) Dec. 1966 74 p refs
(IC-66-9, Rev.) CFSTI: HC $3.00/MF $0.65

The theory of non-relativistic hydromagnetic waves of finite amplitude in a plasma is presented in a simple, but systematic way. The emphasis is on stationary disturbances in a cold plasma. The physical meaning of the cold-plasma model, especially with respect to the description of collisional and collisionless dissipation effects, is discussed.
Author (ESRO)

N67-20310# Toronto Univ. (Ontario). Inst. for Aerospace Studies.
EXPERIMENTS ON THE APPLICATION OF ELECTRON SCATTERING TO PLASMA DIAGNOSTICS
E. L. Battie Dec. 1966 135 p refs
(Contract Nonr-4073(00); Grant DRB-G-9551-02)
(UTIAS-120) CFSTI: HC $3.00/MF $0.65

An experimental apparatus was constructed to test the concept of using Coulomb scattering of injected electron beams

as a plasma diagnostic technique. The experimental conditions were chosen to avoid multiple scattering and plasma oscillation coupling with the beam insofar as possible. The data obtained indicated that these effects had been avoided and that the single Coulomb–Rutherford collision model was the proper one for describing the results over the range of electron densities investigated. Extensive validation experiments were conducted to insure sufficient accuracy of Langmuir probe measurements, which were used for comparison purposes, and the absence of any spurious effects which could influence the beam scattering measurements. Theoretical values of cross sections were derived by averaging the Rutherford results over the length of the interaction zone and over the width of the beam, using experimental data for spatial charge distribution and beam intensity profiles. These values were within 15 percent of the experimentally measured cross sections. The influence of detector angular resolution and beam energy were also measured and found to be in good agreement with Rutherford theory. Author

N67-20342# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

MEASURING THE VELOCITIES OF PARTICLES IN A ROTATING PLASMA THROUGH A FABRY–PEROT INTERFEROMETER WITH PHOTOELECTRIC RECORDING

G. A. Odintsova and Ye. P. Vaulin 27 Sep. 1966 12 p refs Transl. into ENGLISH from Zh. Prikl. Spektroskopii (Moscow), v. 3, no. 2, 1965 p 105–108

(FTD-HT-66-522; AD-643903) CFSTI: $3.00/MF $0.65

The velocities in rotational motion of atoms and ions in a plasma device of the homopolar type that is operating in the stationary regime were determined from the Doppler shift of the spectral lines. We used a Fabry–Perot interferometer with both photoelectric and photographic recording of the interference pattern. A comparison of both methods shows that in problems of this type photoelectric recording has significant advantages over photographic, particularly when the contours of the lines are asymmetric. TAB

N67-20361# Air Force Cambridge Research Labs., Bedford, Mass. Optical Physics Lab.

ON THE "SATURATION" LUMINANCE OF HIGH-DENSITY MICROSECOND-ARC CHANNELS Scientific Interim Report

Heinz Fischer and Lothar Michel Oct. 1966 13 p refs *Its* Phys. Sci. Res. Paper No. 272

(AFCRL-66-691; AD-643515) CFSTI: HC $3.00/MF $0.65

The emission of high-current microsecond-arc channels with a 1-MM gap has been studied in argon and helium by means of a 20-nsec Kerr-cell shutter and profiles of the relative luminance B determined from photographs of the arc image. The method is practically unaffected by instabilities in arc position, and the accuracy of relative luminance values has been perfected to a scatter smaller than plus or minus 5%. From maximum values of the 'saturation' luminance B^* in the axis of the arc channel observed over a wide range of arc current altered by the gas pressure, a ratio of $B^*He/B^*a = 1.52$ for the two gases has been determined. The luminance profile across the arc channel demonstrates increasing opacity after saturation is reached. Author (TAB)

26 PHYSICS, SOLID-STATE

Includes semiconductor theory; and superconductivity. For applications see: 16 Masers. For related information see also: 10 Electronics.

N67-19453# Northwestern Univ., Evanston, Ill. Materials Research Center.

NO TITLE Annual Report, 1 Oct. 1965–30 Sep. 1966

30 Sep. 1966 135 p refs

(Contract ARPA SD-67),

(AR-7; AD-642789) CFSTI: HC $3.00/MF $0.65

This seventh report is for the most part a compendium of the reports of the individual researches supported largely or substantially with funds derived from the ARPA Contract. The title of the research project, name of professor concerned, the source of his main financial support, the objective of the research, the approach used and the progress to date are given. TAB

N67-19460# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Techology Div.

THE THEORY OF INFRARED ABSORPTION IN CRYSTALS

V. Kashcheyev 7 Oct. 1966 17 p refs Transl. into ENGLISH from Latvijas PSR Zinatnu Akad. Vestis (Riga), no. 11, 1963 p 63–71

(FTD-HT-66-210/1+4; AD-644007) CFSTI: HC $3.00/MF $0.65

Consideration is given to the infrared absorption spectrum of ionic crystals due to the cubical anharmonism of lattice oscillations. TAB

N67-19499# Chalmers Univ. of Technology, Goteborg (Sweden). Research Lab. of Electronics.

BOUNDARY CONDITIONS FOR FERROMAGNETIC MEDIA

Paul R. McIsaac 1 Aug. 1966 26 p refs

(Contract AF 61(052)-890)

(TN-1; RR-69; RADC-TR-66-816; AD-644369) CFSTI: HC $3.00/MF $0.65

The report discusses the boundary conditions for ferromagnetic media when the spatial dispersion produced by the exchange effect is included. The boundary conditions for the electromagnetic fields are generalized, and a new boundary condition for the magnetization is derived. Reflection and transmission at a plane interface provides an illustration. Author (TAB)

N67-19632# Atomic Energy Commission, Washington, D. C.

THE SEEBECK COEFFICIENTS OF IRON FROM 0°C TO 1000°C AND TUNGSTEN FROM 0°C TO 1300°C

W. Fulkerson and J. P. Moore *In its* High Temp. Thermometry Mar. 1966 6 p refs (See N67-19621 09-22) CFSTI: HC $3.00/MF $0.65

The Seebeck coefficient of a high purity iron and an Armco iron were measured relative to platinum in conjunction with the determination of electrical resistivity over the temperature range 0 to 1000°C. The temperature gradient was measured using two Pt vs Pt-10% Rh thermocouples which were spot welded to the specimen. Total error in the Seebeck measurement was about 8%. Smoothed results for the two irons are tabulated. The sign of the coefficient was positive. Values for the two irons were identical above 550°C. Below 550°C the difference between the irons increased with decreasing temperature until at 0°C where the purer iron was 8% higher than the Armco iron. The Seebeck coefficient of a hot extruded powder metallurgy tungsten was measured from 0 to 1300°C in conjunction with thermal conductivity and electrical resistivity measurements. Utilized were thermocouple wires which made pressure contacts with the specimen rather than being welded, and radial heat flow thermal conductivity apparatus. In the latter method, the determinate error in temperature and thermal emf measurements was 1%, and the estimated total error was 3%. Smoothed tungsten results are tabulated. The coefficient for iron was positive and increased monotonically throughout the temperature range. Absolute Seebeck coefficient values were all positive but there was a maximum between 1050 and 100°C. S.C.W.

N67-19659# Chicago Univ., Ill. Dept. of Physics.
THE PSEUDOHARMONIC THEORY OF LATTICE VIBRATIONS
Morrell H. Cohen and Richard M. Martin [1966] 3 p refs Sponsored by ARPA
(Contract Nonr-2121(22))
(AD-640944) CFSTI: HC $3.00/MF $0.65

A self-consistent harmonic hamiltonian is derived to describe lattice vibrations in an anharmonic crystal. The force constants are shown to be both self-consistent averages of derivatives of the instantaneous potential energy and derivatives of the free energy with respect to the mean atomic positions at all temperatures. Questions of thermodynamic stability and structural phase transitions are thus embraced by the present theory. Author (TAB)

N67-19671# Columbia Univ., New York. Dept. of Electrical Engineering.
ALTERATION OF CRYSTAL WAVE FUNCTIONS BY LATTICE DEFECTS
David Redfield Sep. 1966 13 p refs
(Contract Nonr-4259(16))
(CU-3-66-Nonr-4259(16)-EE; TR-97; AD-640709) CFSTI: HC $3.00/MF $0.65

Most types of lattice defects are shown to be capable of altering the wave functions of the intrinsic electronic states of solids. This alteration is caused by the strong electric fields arising at charged defects of all types. The effect is similar to that by which a uniform field changes Bloch functions to Houston functions. A number of consequences follow from the changes caused by the modified wave functions in the matrix elements for electronic transitions. Charges in the fundamental optical absorption edge and in the exciton spectrum are shown to be among these consequences. The application of these results to scattering of current carriers in heavily doped semiconductors is suggested. Author (TAB)

N67-19708# Air Force Cambridge Research Labs., Bedford, Mass. Solid State Sciences Lab.
CRYSTAL PERFECTION OF α-Al_2O_3 AS A FUNCTION OF GROWTH METHOD
Charles S. Sahagian Sep. 1966 38 p refs *Its* Phys. Sci. Res. Paper No. 268
(AFCRL-66-659; AD-642040) CFSTI: HC $3.00/MF $0.65

Synthetic ruby and sapphire crystals grown by flame-fusion and flux methods are described and discussed in terms of growth method and growth techniques. Dislocation densities are given for all samples, and comparisons are made in an attempt to obtain correlation between the growth method used and the resulting lattice defect structure. Data are presented for crystals grown by various methods, namely, Verneuil, flux, hydrothermal, electron-beam zone refining, Czochralski, vapor deposition, and plasma torch methods. Dislocation density evaluation is based on chemical etchpit analysis, which produced average dislocation density values varying from about 1,000,000/sq cm for crystals grown by the plasma torch method to about 1000/sq cm for crystals grown by the electron-beam method. Crystals grown by the other methods mentioned about show dislocation densities lying between these values. A brief description is presented of the chemical etching techniques and apparatus used at AFCRL. Author (TAB)

N67-19710# Massachusetts Inst. of Tech., Cambridge. Solid-State and Molecular Theory Group.
NO TITLE Quarterly Progress Report No. 62
G. F. Koster et al 15 Oct. 1966 71 p refs
(Contract Nonr-1841(34); Grants NSF G-24908; NSF GP-3241)
(AD-642566) CFSTI: HC $3.00/MF $0.65

Contents: Energy bands for ferromagnetic nickel and europium sulfide, by J. W. D. Connolly, S. J. Cho, J. B. Conklin, Jr., and J. C. Slater; Preliminary results on the spin density of iron, by P. DeCicco and A. Kitz; Some consequences of the thermal Hartree-Fock approximation at zero temperature, by J. Sokoloff; The energy band problem for a deformed lattice, by J. Kenney; The classical origin of the Schrodinger equations and the Darwin correction terms, by R. Gilmore; Recursion formulae and computation methods for the bipolar expansion of 1/r sub 12, by D. E. Ellis and W. E. Palke. TAB

N67-19711# Case Inst. of Tech., Cleveland, Ohio.
DEPOSITION OF CARBON ON DIAMOND SEED CRYSTALS Interim Scientific Report
John C. Angus and Herbart Will 9 Sep. 1966 14 p refs
(Contract AF 19(628)-4785)
(SR-4; AFCRL-66-686; AD-642786) CFSTI: HC $3.00/MF $0.65

Experiments were performed to establish the feasibility of growing diamond crystals for potential electronic device application by the deposition of carbon on diamond seed crystals at moderate pressures. Methane at temperatures and pressures on the order of 1050C and 1 mm Hg was used as the source of carbon. Weight increases were consistently observed when pure methane was used as the source of carbon. When the methane was diluted with either hydrogen or helium, the seed crystals decreased in weight. Preliminary investigation of the crystals by Debye-Scherrer X-ray patterns, chemical kinetic studies and visual observation indicate the observed increase in mass is diamond. More definitive studies to verify this conclusion are underway. Author (TAB)

N67-19713# Rutgers Univ., New Brunswick, N. J. Dept. of Physics.
ULTRASONIC ATTENUATION OF PURE STRONG-COUPLING SUPERCONDUCTORS
James W. F. Woo Nov. 1966 29 p refs Prepared in part at Cornell Univ. Sponsored in part by NSF
(Contract Nonr-401(38))
(TR-16; AD-642104) CFSTI: HC $3.00/MF $0.65

The low frequency longitudinal ultrasonic attenuation of strong-coupling superconductors is discussed. The starting point is a formula due to Kadanoff and Falko which expresses the attenuation in terms of various correlation functions. These functions were evaluated in the ladder approximation. The results are valid for all values of QL (L-electron mean free path, Q-phonon wave number). In the $QL >> 1$ limit, the contribution of the density-density correlation function is dominant and Ambegaokar's result is obtained for the reduced attenuation (ratio of attenuation in superconducting to normal states). In the $QL << 1$ limit, all correlation functions are equally important. The reduced attenuation is a function of Q and differs from the results of the BCS isotropic model. Numerical calculations for the reduced attenuation in lead was performed for various values of Q which satisfies $QL << 1$. The results are in rough agreement with that of Deaton's experiment. Author (TAB)

N67-19714# Eagle-Picher Co., Miami, Okla. Electronics Div.
RESEARCH IN PURIFICATION AND SINGLE CRYSTAL GROWTH OF II–VI COMPOUNDS Quarterly Progress Report, 15 Jul.–14 Oct. 1966
14 Oct. 1966 32 p
(Contract AF 33(615)-2947)
(QPR-6; AD-642450) CFSTI: HC $3.00/MF $0.65

Compounds synthesized were CdS, ZnS, CdSe and ZnSe. The purity of the CdS remained at a level of about 6 - 9s. Analysis of the zinc compounds indicates somewhat lower purity and efforts to improve this situation were initiated. Crystallization of CdS, CdSe, and ZnS was accomplished from the vapor phase. TAB

N67-19745# Westinghouse Electric Corp., Elmira, N. Y. Electronic Tube Div.
SOLID STATE IMAGE INTENSIFIERS Monthly Technical Engineering Report, 1 Jul.–31 Jul. 1966
Z. Szepesi, ed. 9 Aug. 1966 6 p *ref*
(Contract N61339-66-C0064)
(MTER-4; AD-642933) CFSTI: HC $3.00/MF $0.65

Series of experiments were carried out for decreasing in dark currents in sintered CdSe layers. A batch of CdS powder with 1% ZnS was prepared and is being evaluated. Cr-SiO films were deposited and image intensifier panels are being built on them. Image intensifier panels were built with insulating optical black films between the PC and EL layers. A combination display system by projecting a laser scanned image on the PC-EL image intensifier was demonstrated. Author (TAB)

N67-19752# Case Inst. of Tech., Cleveland, Ohio. Solid State Group.
FERROMAGNETIC RESONANCE IN A TWO BAND FERROMAGNET Interim Scientific Report
Thomas A. Uhrig Sep. 1966 83 p refs
(Grant AF-AFOSR-857-65)
(Rept.-66-26; AFOSR-66-1906; AD-642109) CFSTI: HC $3.00/MF $0.65

The classical two band ferromagnetic model is formulated which corresponds to the current quantum mechanical multiple electronic band model. The effective exchange interactions (including one electron as well as exchange contributions) are introduced as effective exchange fields; and the dynamical equations of motion of the magnetization, coupled with Maxwells equations, are solved for ferromagnetic resonance. The solution for a single band ferromagnet has two pairs of modes of the same form as the insulator theory modes, except for the method of calculating the exchange parameters. In addition to the acoustic and electromagnetic pairs of modes (corresponding to the single band solutions), the two band ferromagnet has an additional pair of optical modes. The incremental band magnetizations for the optical modes are opposite in direction and tend to cancel. For identical bands cancellation is exact and coupling to the optical mode is not possible. For nonidentical bands, coupling is possible as the cancellation is not complete. For typical parameters of nickel, computer solution gives the dispersion relations and shows a resonance of the right polarized optical mode in the infrared near six microns.
Author (TAB)

N67-19767# Cornell Univ., Ithaca, N. Y. Materials Science Center.
F-CENTER FORMATION BY FUNDAMENTAL ABSORPTION IN KI
Fred Tobias Goldstein (Ph.D. Thesis) Sep. 1966 104 p refs
(Contract Nonr-401(47))
(Rept.-545; TR-8; AD-643486) CFSTI: HC $3.00/MF $0.65

The experimental techniques employed in this work consisted of irradiating a KI crystal with ultraviolet and, in some cases, additional visible light. This irradiation resulted in the growth of color centers which were studied by measuring the growth of the absorption bands associated with the centers. The effect of bleaching on the growth was studied and in addition, various luminescence measurements were performed. TAB

N67-19777# Navy Electronics Lab., San Diego, Calif.
OPTICAL PROPERTIES OF METALS AND SEMICONDUCTING MATERIALS Research Report, Jan.–Jul. 1966
T. G. Pavlopoulos 22 Aug. 1966 33 p refs
(NEL-1397; AD-643755) CFSTI: HC $3.00/MF $0.65

Theory of electrical and optical properties of conducting media is reviewed. Properties of thin films (thickness less than 200 angstroms) are shown to be affected by reduction of the mean free path of an electron by the boundaries of the film. Changes in properties by lattice imperfections or impurities are traced to incorrect preparation of films. A program is outlined to enlarge understanding of metals and semiconductors by investigation of films prepared by ultrahigh-vacuum techniques. Boundary effects, surface phenomena, and consideration of lattice defects and impurities are included. Author (TAB)

N67-19802# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
FERROACOUSTIC RESONANCE IN MAGNETIC MEDIA
M. A. Savchenko, V. V. Hann, and P. V. Ryabko 7 Dec. 1966 19 p refs Transl. into ENGLISH from Ukr. Fiz. Zh. (Kiev), v. 10, no. 3, 1965 p 263–274
(FTD-HT-66-217; TT-67-60189; AD-643600) CFSTI: HC $3.00/MF $0.65

Ferroacoustic resonance in ferromagnets and antiferromagnets is studied with an allowance for the boundary. The resonance amplitudes were determined from magnetic (spin) waves excited by an external acoustic field. The coefficients of absorption of magnetoacoustic vibrations at resonance were also determined. The excitment of magnetic (spin) waves by an external acoustic field at the boundary is considered and the general boundary conditions depending on the exchange forces, the surface-anisotropy field and surface magnetestriction were determined. It is shown that in antiferromagnets where magnetic moments are at an angle with respect to a strong magnetic field H, the magnetic moments of the sublattices gradually collapse near the boundary. In this case the distortion depth of the magnetic structure is equal to a multiple of the lattice constant. In the approximation of weak surface anisotropy the resonance amplitudes of spin waves excited by an external acoustic field and the absorption coefficients of coupled vibrations at resonance are determined. Author (TAB)

N67-19809# Carnegie Inst. of Tech., Pittsburgh, Pa. Dept. of Physics.
MAGNETIC ORDERING IN $Mn(HCOO)_2 \cdot 2H_2O$ AND RELATED COMPOUNDS
Russell D. Pierce and Simeon A. Friedberg 1 Oct. 1966 12 p refs Submitted for publication
(Contract Nonr-760(26))
(TR-4; AD-642364) CFSTI: HC $3.00/MF $0.65

The heat capacities of the isostructural dihydrated formates of Mn(++), Fe(++), and Ni(++) were measured between 1.4 and 20K. Sharp peaks associated with long-range spin ordering are found at 3.72K for Mn(HCOO)2.2H2O, 3.74K for Fe(HCOO)2.2H2O, and 14.5K for Ni(HCOO)2.2H2O. An additional sharp anomaly in Cp is found at 1.72K for the Mn(++) salt, while Cp of the Ni(++) salt exhibits a Schottky-like maximum at 3K. Each of these anomalies can be correlated with some feature of the observed magnetic susceptibilities. A unit cell in these salts contains two each of two inequivalent metal ion sites, types A and B. Formate groups constitute AA and AB bridges and appear to mediate the dominant superexchange couplings. A simplified molecular field treatment of Mn(HCOO)2.2H2O in which JAA = 0.65 k, JAB = -0.10 k, and JBB = 0 provides interpretations of several striking effects. In particular, it shows that below a common transition temperature, B spins order much more slowly than A spins and are nearly free at 1K as seen in both magnetic and thermal data. Analysis of the data for the Ni(++) and Fe(++) salts suggests that the effective spins of A and B ions may differ in a given substance. Author (TAB)

N67-19827# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
ENERGY STRUCTURE OF ALUMINUM ANTIMONIDE ZONES

V. V. Sobolev 21 Nov. 1966 8 p refs Transl. into ENGLISH from Zh. Prikl. Spedtroskopii, Akad. Nauk Belorussk. SSR (Minsk), v. 3, no. 4, 1965 p 372–374
(FTD-HT-66-490; AD-643624) CFSTI: HC $3.00/MF $0.65

Four bands are found in the reflection spectrum of aluminum antimonide at a temperature of 25C in the 1-6 ev region. The origin of the bands is explained on the basis of a diagram of direct allowed interzonal transitions at certain points. Author (TAB)

N67-19901*# Stanford Univ., Calif. Electronics Labs.
CRYSTAL FIELD SPECTRA OF 3d^n IMPURITIES IN II–VI AND III–V COMPOUND SEMICONDUCTORS
J. M. Baranowski, J. W. Allen, and G. L. Pearson [1965] 29 p refs
(Grant NsG-555)
(NASA-CR-82959) CFSTI: HC $3.00/MF $0.65 CSCL 20L

The spectra of Fe(d^6) in ZnSe, ZnTe, CdS, CdTe, GaP and GaAs, and of Co(d^7) in ZnSe, ZnTe, GaP and GaAs, are presented. It is found that a crystal field description is useful even in such covalent materials. The crystal field splitting, Δ, depends on the impurity but, for a given impurity, Δ varies by less than 25% through the II–VI series. The Racah parameter B is strongly dependent on the host crystal and can decrease to less than a third of the free-ion value. From plots of the variation of B and Δ with properties of the impurity or host crystal, the spectra of hitherto unexplored systems may be predicted. Author

N67-19915*# Autonetics, Anaheim, Calif.
PHOTOCONDUCTOR CONFIGURATION STUDY Final Report
28 Feb. 1967 68 p refs
(Contract NAS1-5314)
(NASA-CR-66319; C7-478/201) CFSTI: HC $3.00/MF $0.65 CSCL 20L

The objective of the photoconductor configuration study was to evaluate several volume effect, cadmium sulfide, position sensitive photodetectors for space star-tracking applications. A position sensitive detector indicates both the presence of a star image and the position of the image on the photodetector. Five photodetectors were fabricated and evaluated in both single-axis and two-axis detection configurations. A description of volume effect, cadmium sulfide photoconductors, the theory of each detection technique, fabrication processes, test procedures, and test results are presented. The test results are discussed and evaluated. Recommendations for further work are also presented. Author

N67-19925*# Stanford Univ., Calif. Solid-State Electronics Lab.
A CRYSTAL FIELD ANALYSIS OF COBALT IMPURITIES IN GaP
Douglas H. Loescher Oct. 1966 76 p refs
(Grant NsG-555)
(NASA-CR-82965; SEL-66-087; TR-5109-2) CFSTI: HC $3.00/MF $0.65 CSCL 20L

Crystal field theory has been used to explain the electrical and optical properties of cobalt-doped GaP. In n-type GaP, cobalt gives rise to optical absorption bands at 0.8 and 1.25 microns. From Hall effect data it has been found that cobalt is a deep acceptor with an ionization energy of 0.41 eV. A crystal-field analysis has shown that the electron configuration around full cobalt acceptors consists of seven d-electrons with all other electrons in closed shells, and furthermore, that cobalt atoms have substituted for gallium atoms in the lattice. In general, the analysis has shown that crystal field theory can be used to obtain detailed electron models of semiconductor impurities. Methods were developed to grow epitaxial single crystals of GaP doped with either sulfur or zinc, and predictable sulfur dopings between 6×10^{16} and 4×10^{18} cm^{-3} were achieved. Diffusion data show that the cobalt diffused both substitutionally and interstitially. The data suggest that the cobalt concentration after diffusion was determined by a nonequilibrium density of crystal defects. Author

N67-19950*# General Electric Co., Schenectady, N. Y.
RESEARCH ON MAGNESIUM ANTIMONIDE AND MAGNESIUM BISMUTHIDE AS THERMOCOUPLE MATERIALS FOR THERMOELECTRIC POWER GENERATION
James H. Bredt and Louis F. Kendall Jan. 1967 58 p refs
(Contract NASw-1307)
(NASA-CR-82949) CFSTI: HC $3.00/MF $0.65 CSCL 20L

An experimental study was made of the preparation and properties of Mg_eSb_2 and Mg_3Bi_2. Methods of preparing pure, stoichiometric samples were successfully developed. High-temperature electrical property measurements were made on one sample of each compound. Satisfactory measurement methods were found, and it appears that Mg_3Bi_2 is probably a semimetal at high temperatures and a semiconductor at low temperatures. However, the data were insufficient for a final conclusion on thermoelectric applications. The compounds' room temperature thermal conductivities were measured, and it was found that an alloy with the formula $Mg_3Sb_{0.4}Bi_{1.6}$ had a lower thermal conductivity than either pure material. Author

N67-19951* Cornell Univ., Ithaca, N. Y. Dept. of Engineering Physics.
GAS-SURFACE PROCESSES AND LEED
John W. May [1966] 21 p refs
(Grant NGR-33-010-029; Contract AISI-148)
(NASA-CR-82948) CFSTI: $3.00 CSCL 20L

Discussed is low energy back-reflection electron diffraction (LEED) as a method for studying monocrystalline surfaces, either in the clean state or with adsorbed substances. Experiments illustrating electron penetration, surface conditions, adsorption characteristics, chemisorption, and the effects of heating are described. The experiments involved nickel and tungsten surfaces after adsorption of oxygen. K.W.

N67-19980# Westinghouse Electric Corp., Elmira, N. Y. Electronic Tube Div.
SOLID STATE IMAGE INTENSIFIERS Monthly Technical Engineering Report, Oct. 1–31 1966
M. A. Novice and Z. Szepesi, ed. 11 Nov. 1966 5 p
(Contract N-61339-66-C-0064)
(Rept.-7; AD-643717) CFSTI: HC $3.00/MF $0.65

A series of experiments was made for checking the reproducibility and improving the uniformity of the image intensifier panel. Panels were made on titanium dioxide coated substrates and with repeated settling and sintering of the PC layer. Experiments have been started with CdS. Several batches of doped powders were prepared with copper and chlorine, bromine, and iodine impurities. Field excited currents have been recorded and will be evaluated. Insulating opaque films with acceptable characteristics were prepared by evaporating indium and magnesium fluoride. Demonstration samples of black films, EL panels and image intensifier panels were prepared. Author (TAB)

N67-20159# California Inst. of Tech., Pasadena. W. M. Keck Lab. of Engineering Materials.
ELECTRICAL RESISTIVITY OF SmAg, SmCu, AND SmAu
C. C. Chao and Pol Duwez Nov. 1966 12 p refs
(Contract AT(04-3)-221)
(CALT-221-25; Rept.-47) CFSTI: HC $3.00/MF $0.65

Electric resistivity vs. temperature curves of the three equi-atomic phases of Sm with Cu, Ag, and Au show several

anomalies, which are probably related to magnetic transitions. The fact that curves show very little similarity is probably due in part to the different crystal structures of these three phases, which in turn indicates a lack of similarity in the alloying behavior of Cu, Ag, and Au with Sm. The SmCu and SmAu phases can be made to crystallize into a CsCl structure isomorphous with SmAg by rapid quenching from the liquid state. However, in the process of quenching, these two alloys break up into small pieces only a few mm in length and no reliable electrical resistivity measurements were obtained. Measurements on the rapidly quenched alloys would make possible a direct comparison of the magnetic properties of the three Sm phases with Cu, Ag, and Au with the same CsCl type crystal structure. Author (NSA)

N67-20199# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
MICROHARDNESS OF SOME COMPLICATED DIAMOND-LIKE SEMICONDUCTORS
A. S. Borshchevskiy, N. K. Takhtareva, and D. N. Tret'yakov 27 Jun. 1966 5 p Transl. into ENGLISH from Tr. Yestestvennotekhnicheskiye Nauki (Kishinev), no. 1, 1964 p 10
(FTD-HT-66-114; TT-67-60260; AD-643735) CFSTI: HC $3.00/MF $0.65

A series of semiconductor heterovalent compounds (divalent and trivalent) forming five developed iso-electronic series were prepared. The members of these series have the diamond, zinc blends, and chalcopyrite structures or ones close to them. The general tendence of change in microhardness in these series is a lowering with a gain in ionic quality. Measurements on monocrystalline objects apparently will provide the possibility of refining this conformity to law. The qualitative consideration of the dependence of the microhardness on the composition in the isovalent solid solutions of diamond-like substances enables one to draw the following conclusion: this dependence is reflected by a smooth curve (in accordance with Kurnakovs law.) As is shown by observation in the majority of the systems this maximum will shift in the direction of the harder component. TAB

N67-20200# Sperry Microwave Electronics Co., Clearwater, Fla.
LOW MAGNETIC SATURATION GARNETS Quarterly Progress Report, 1 May–31 Jul. 1966
W. R. Wilson, G. P. Rodrigue, L. R. Hodges, Jr., and G. R. Harrison Dec. 1966 54 p
(Contract DA-28-043-AMC-01205(E))
(SJ-220-0056-6, Rept.-6; QPR-6; ECOM-01205-6; AD-644604) CFSTI: HC $3.00/MF $0.65

Ten single crystal runs consisting of YCaVIG, BiCaVIG, YBiCaVIG and BiCaV(Al)IG were prepared and evaluated. Good quality crystals were grown in each of the four above garnet series. The temperature dependence of the first and second order magnetocrystalline anisotropy constants, and therefore the effective anisotropy field, of three different BiCaVIG compositions have been measured. The anisotropy field for these materials decreases linearly with increasing temperature (- 180 to + 25C). Polycrystalline samples of Y1.6Ca1.4V0.7AlwFe4.3-wO12 were prepared for w = 0 to 0.5. Lattice constant, theoretical density, linewidth and magnetization for this series of compositions are reported. The temperature characteristics of the microwave properties for the Bi3-2yCa2yVyFe5-yO12 family are reported for y = 1.1 to 1.4. A discussion of the discrepancy between the polycrystalline and single crystal magnetization measured on ostensibly the same composition is presented. Several possible explanations are presented, however, the problem remains unresolved. Bi0.4Ca2.6V1.3Fe3.7O12 single crystal and polycrystalline samples have been evaluated in an S-band Y-junction circulator. Operating characteristics are reported for 25C and 77K. Author (TAB)

N67-20254* Naval Ordnance Test Station, China Lake, Calif.
THEORETICAL AND EXPERIMENTAL INVESTIGATIONS OF THE PHYSICS OF CRYSTALLINE SURFACES Annual Report, 1 Feb. 1966–31 Jan. 1967
E. Bauer 31 Jan. 1967 68 p refs
(NASA Order R-05-030-001)
(NASA-CR-82855) CFSTI: HC $3.00 CSCL 20B

In studies of the physics of crystalline surfaces the following topics are considered: (1) the relation between structure of epitaxial films and surface and interfacial energies; (2) elastic and inelastic interactions of slow electrons with tungsten single crystal surfaces; (3) determination of nature and structure of surface layers with low energy electron diffraction; (4) the relation between structure and electron emission properties of work function reducing layers on tungsten planes; (5) momentum exchange of atoms on well defined single crystal surfaces; and (6) the theory of low energy electron scattering. Next, it is illustrated that superstructure patterns can be interpreted in terms of double scattering between structures well known from bulk crystal structure analysis, involving only minor lattice distortions of the surface layers. Finally, the subject of linear unfolding methods and optimization for X-ray and similar spectra is considered. The importance of optimization is demonstrated on the basis of comparative accuracy considerations, including both variance and expectation value of solutions. S.P.

N67-20256* Rice Univ., Houston, Tex.
MICROWAVE ABSORPTION IN DYSPROSIUM SINGLE CRYSTALS
H. A. Blackstead and P. L. Donoho [1967] 11 p refs
(Grant NsG-6-59)
(NASA-CR-82851) CFSTI: HC $3.00 CSCL 20L

Microwave power absorption at a frequency of 9.8 GHz in single-crystal c-plane platelets of dysprosium at temperatures from 40°K to 179°K was observed. The rf magnetic field was aligned parallel to an a-axis (easy axis), and the dc magnetic field was aligned along a b-axis (hard axis), either perpendicular to the rf field or at an angle of 30 degrees to it. At temperatures below 85°K, and for temperatures from 85°K to approximately 110°K with $H_{dc} > H_c$, a strong resonance line with a width of approximately 1 kOe was observed. This resonance, predicted from spin-wave analysis, is apparently related to the strong six-fold basal-plane anisotropy which is important below 110°K. With the dc field perpendicular to the rf field, and for temperatures above 110°K, there was no apparent field-dependence of the absorption for $H_{dc} < H_c$. At higher fields, however, the absorption increased rapidly, reaching a maximum at H_f, the field at which the fan structure has collapsed to ferromagnetic alignment. With further increase of the field, the absorption then decreased linearly. Author

N67-20278# Brookhaven National Lab., Upton, N. Y.
CANTED ANTIFERROMAGNETISM OF $CuCl_2 \cdot 2D_2O$
H. Umebayashi, G. Shirane, B. C. Frazer, and D. E. Cox. 18 Oct. 1966 4 p refs Presented at 12th Ann. Conf. on Magnetism, Magnetic Mater., and Exhibits, Washington, D. C.
(Contract AT(30-2)-GEN-16)
(BNL-10701; CONF-661107-1) CFSTI: HC $3.00/MF $0.65

Canted antiferromagnetism in $CuCl_2 \cdot 2D_2O$ was confirmed in a neutron-diffraction experiment. The neutron data agree well with the theoretical predictions of Moriya for a minor magnetization component of about $0.1\mu_B$ parallel to the c axis. The angular dependence of the neutron data indicates that the spatial distribution of minor magnetization is quite different from that of the main component. Author (NSA)

N67-20311# Gt. Brit. Ministry of Aviation, London. Technical Information and Library Services.
MEASUREMENT IN CENTIMETRE WAVES OF THE DIELECTRIC CONSTANTS OF VARIOUS SUBSTANCES [DIE MESSUNG DER DIELEKTRIZITAETSKONSTANTEN VON VERSCHIEDENEN STOFFEN IN ZENTIMETERWELLEN]
K. Bakin Dec. 1966 9 p refs Transl. into ENGLISH from Bull. Tech. Univ. Istanbul (Turkey), v. 16, no. 1, 1963 p 29–37
(TIL/T-5711) CFSTI: HC $3.00/MF $0.65

The application of short-circuit, short and open-circuit and impedance transformer methods is described. A measuring conductor of 3 cm is used for the measurement, and the length of the material varied. Odd numbers are chosen as quarter wavelengths as the characteristic length of the material. For the measurement of tan δ_d the length d is chosen as $n(\lambda t/2)_{dg}$. Author

N67-20315# Gt. Brit. Ministry of Aviation, London.
THE STATISTICS OF THE SECONDARY ELECTRONIC EMISSION OF NICKEL AND IRON [STATISTIKA VTORICHNOI ELEKTRONNOI EMISSII NIKELYAR I ZHELEZA]
Yu. A. Filippov Dec. 1966 9 p refs Transl. into ENGLISH from Fiz. Tverd. Tela (Leningrad), v. 8, no. 3, 1966 p 877–882
(TIL/T-5706) CFSTI: HC $3.00/MF $0.65

Nickel and iron powders obtained by the carbonyl method were used in the investigation. The solid particles were suspended in the electric field of a condenser in a vacuum. The apparatus made it possible to record the change in the charge of the suspended particle to a magnitude equal to that of the electron charge. The results of the experiments indicate that the statistics of the secondary electron emission at low energies for the primary electrons are close to the Poisson distribution and diverge from it as the energy increases. This divergence from the Poisson distribution is explained by the scattering of the primary electrons in the material of the target area. K.W.

27 PROPELLANTS

Includes fuels; igniters; and oxidizers. For basic research see: 06 Chemistry; and 33 Thermodynamics and Combustion. For related information see also: 28 Propulsion Systems.

N67-19675# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
EFFECT OF SULFUROUS COMPOUNDS ON THERMAL STABILITY AND CORROSIVE PROPERTIES OF FUELS FOR TURBOCOMPRESSOR AIR-REACTIVE ENGINES
P. I. Davydov and G. F. Bol'shakov 25 Apr. 1966 15 p Transl. into ENGLISH of the Publ. "Bor'ba s Korroziyey Dvigateley Vnutrennego Sgoraniya i Gazoturbinnykh Ustanovok" USSR, 1962 p 272–280
(FTD-TT-65-1276; TT-66-62520; AD-641109) CFSTI: HC $3.00/MF $0.65

Conclusions: (1) Aliphatic cercaptanes, contained in fuel as a result of long heating at 150 degrees, cause sharp corrosion of bronze and formation of tars and insoluble residue. It is necessary to reduce the mercaptan content in fuel. (2) The investigated sulfurous compounds, by their corrosive effect on metals and the effect of tar and residue formation processes in fuels during their heating to 150 degrees, are divided into the following descending series: mercaptanes, disulfides, aliphatic sulfides, aromatic sulfides, thiophanes. Author (TAB)

N67-19907* National Bureau of Standards, Boulder, Colo. Cryogenics Div.
CRYOGENIC PROPELLANT FLUID PROPERTIES REPORT FOR DATA EVALUATION PROGRAM Final Report
R. B. Stewart, J. G. Hust, H. J. M. Hanley, R. D. McCarty, L. A. Hall et al 1 Feb. 1966 61 p refs
(NASA Order H-76797; NBS Proj. 315-40-3150422)
(NASA-CR-82961; NBS-9198) CFSTI: $3.00 CSCL 21I

Compilations are presented of thermodynamic properties of oxygen, thermodynamic properties of argon, viscosity and thermal conductivity of argon, viscosity of oxygen, and viscosity of nitrogen. New tables of thermodynamic properties of oxygen from 55° to 300°K with pressures at 0.1, 0.4, 0.7, 1, 4, 7, 10, 40, 70, 100, 200, and 300 atmospheres are included along with new tables for the viscosity and thermal conductivity of gaseous argon from 100° to 2000°K, viscosity of gaseous oxygen from 100° to 2000°K, and viscosity of gaseous nitrogen from 100° to 2000°K. Author

N67-19913*# Pratt and Whitney Aircraft, West Palm Beach, Fla.
IGNITION OF HYDROGEN-FLUORINATED OXIDIZERS Final Report, 30 Jun.–30 Nov. 1966
William J. McAnally, III 15 Mar. 1967 32 p refs
(Contract NAS3-7964)
(NASA-CR-72153; PWA-FR-2222) CFSTI: HC $3.00/MF $0.65 CSCL 21B

Experimental definition of the limits of hypergolicity of fluorine-oxygen mixtures with hydrogen under liquid rocket operating conditions, was accomplished by conducting five series of ignition tests. For each series, a different percentage of fluorine in the flox mixture was used, and tests were conducted at mixture ratios of approximately 1, 5 and 8. High-frequency response instrumentation was used to sense ignition of cold gaseous hydrogen with pure fluorine and flox mixtures containing 53.4, 50.2, 46.5 and 39.5% fluorine under altitude conditions in a small-scale rocket engine which was liquid nitrogen cooled. Rapid ignition with minimum variation in delay times was demonstrated with pure fluorine. No ignition was recorded for the tests conducted with 39.5% fluorine in flox, whereas in the tests conducted with concentrations of 46.5, 50.2 and 53.4% fluorine in flox, ignition and/or sustained combustion was not obtained under all conditions. These results indicate that for practical design purposes the flox concentration necessary for consistent ignition is sufficiently high to require that vehicle and engine systems using the mixture must be compatible with pure fluorine. Author

N67-19972# Rocket Propulsion Establishment, Westcott (England).
THE IGNITION OF SOLID PROPELLENTS BY RADIANT ENERGY
D. Sutton and P. C. Wellings Apr. 1966 38 p refs
(RPE-TR-66-4)

Various types of solid propellents have been ignited by radiant energy in an arc-image furnace at heating rates varying between 2 and 300 cal cm^{-2} sec^{-1} and pressures varying between 2×10^{-3} and 300 lb/in^2 absolute. Seven of the propellents contained ammonium perchlorate or potassium perchlorate as oxidizer and the fuels were polyisobutene, polyurethane, or polybutadiene-acrylic acid copolymer. Two of the propellents were of the double-base variety. The gaseous environments were air, nitrogen, or oxygen. With three exceptions, the ignition energy requirements of the propellants tested were found to decrease as the radiant heat flux was increased up to 20 cal cm^{-2} sec^{-1}. At higher heating rates the ignition energy requirement remained constant. For the three exceptions, minimum energy requirements were obtained with heating rates near to 100 cal cm^{-2} sec^{-1}. As the ambient pressure was increased from subatmospheric to atmospheric, the

energy required for ignition diminished to a minimum and remained at this minimum as the pressure was increased further. The use of an "ignition temperature" determined experimentally at low rates of heating is not valid for the calculation of ignition delay times under high rates of heating as exist in practical motor ignition systems. The relevance of the data now reported to the ignition of solid propellent rocket motors and their relevance to the various theories of solid propellent ignition is discussed. Author

28 PROPULSION SYSTEMS

Includes air breathing, electric, liquid, solid, and magneto-hydrodynamic propulsion. For nuclear propulsion see: 22 Nuclear Engineering. For basic research see: 23 Physics, General; and 33 Thermodynamics and Combustion. For applications see: 31 Space Vehicles. For related information see also: 27 Propellants.

N67-19573# RAND Corp., Santa Monica, Calif.
THRUST DEFLECTION FOR CRUISE
W. H. Krase Sep. 1966 12 p ref
(P-3450; AD-640616) CFSTI: HC $3.00/MF $0.65

The effects of lift/drag ratio and gross-thrust/ram-drag ratio on the benefits to be obtained from thrust deflection are analyzed, and it is shown that combinations of low values of these parameters can result in a substantial advantage. For instance, at a lift/drag ratio of 4 and a gross-thrust/ram-drag ratio of 1.1, the range may be increased about 34 percent. The required increases in altitude and in engine capture area are also shown. Author (TAB)

N67-19662# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
SELECTION OF THE OPTIMUM PARAMETERS OF A SUPERSONIC RAMJET ENGINE WITH A HEAT EXCHANGER
V. T. Vorogushin 18 Apr. 1966 13 p refs Transl. into ENGLISH from Izv. Vysshikh. Uchebn. Zavedenii, Aviats. Tekh. (Kazan), no. 4, 1961 p 75–81
(FTD-TT-65-581; TT-66-62522; AD-641111) CFSTI: HC $3.00/MF $0.65

The work contains the procedure for computing the supersonic ramjet engine with a heat exchanger. In it there is analysed the influence of the temperature of heat, the flow T*, and the speed of flight on the value and the coefficient of thrust, and the influence of a series of parameters on the required heat emitting surface. The results of the work enable one to proceed with the choice of the original optimum parameters in the computation of the supersonic ramjet engine with a heat exchanging apparatus. Author (TAB)

N67-19707# Curtiss-Wright Corp., Wood-Ridge, N. J. Wright Aeronautical Div.
SINGLE ROTOR ENGINE—FEASIBILITY Final Report
23 Jul. 1966 33 p refs Revised
(Contract NOw-63-0318-c)
(WAD-268/F, Rev.; AD-642257) CFSTI: HC $3.00/MF $0.65

The single rotor engine concept is a gas turbine engine configuration utilizing a single stage axial flow compressor which has interwoven through the compressor blading and disk a radial inflow-axial exit turbine. Thus, the rotating elements are uniquely combined within a single disk. The complete gas generator consists of stationary inlet guide vanes, the rotor, compressor exit stators and diffuser, combustion chamber, turbine nozzle assembly, and a turbine discharge diffuser. An experimental program was undertaken in which the feasibility of the concept was investigated. The effort involved the design, fabrication, and test of a turboshaft version of the concept. The Curtiss-Wright designation for this unit is WTS-11. During the course of the investigation, a total of 137 hours 50 minutes test time was accumulated in the component test phase of the work. A good understanding of the operating characteristics of the compressor, turbine, and combustionchamber was achieved. A self-sustaining gas generator run is possible, utilizing these components (which are not fully developed) at lower-than-design turbine entry temperature. TAB

N67-19889*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
INLET SENSITIVITY STUDY FOR A SUPERSONIC TRANSPORT
Robert W. Koenig Washington, NASA, Mar. 1967 35 p refs
(NASA-TN-D-3881) CFSTI: HC $3.00/MF $0.65 CSCL 21A

A means of comparing inlet performance and weight compromises is presented. It shows values of inlet drag coefficients and pressure recovery as a function of Mach number. These values are systematically varied from reference inlet values. It compares the effect of these changes on the basis of payload and passenger carrying capability of a fixed-ramp gross-weight supersonic transport. The transport uses four after-burning turbojet engines to fly analytically a 3500 nautical mile mission. The inlet parameters examined are cowl-lip and nacelle-wave drag, boundary-layer bleed drag, inlet-total-pressure recovery, skin-friction drag, transonic excess-flow drag, and inlet weight. An example is included that shows assumed inlet drag and weight parameters for five inlet types. It compares the changes in inlet parameters to a reference inlet. It then relates these changes to passenger carrying capability of the supersonic transport, and it compares the inlets on this basis. Author

N67-19895*# Rocket Research Corp., Seattle, Wash.
SUBLIMING SOLID CONTROL ROCKET, PHASE I Final Report
Washington, NASA, Mar. 1967 163 p
(Contract NAS5-3599)
(NASA-CR-711) CFSTI: HC $3.00/MF $0.65 CSCL 21H

The subliming solid control rocket is an attitude control propulsion device employing a solid propellant which slowly sublimes to a low molecular weight vapor. This vapor is exhausted by means of propellant valves through nozzles to produce reaction thrust. The principal advantage of the subliming solid control rocket is that its propellant is stored at high bulk density and low pressure. This permits the use of small, low weight propellant tanks and minimizes leakage. A development program has as its principal goals the examination of the fundamental operating principles of the subliming solid control rocket and to study optimization of components. This Phase I final report deals with the concept of operation of the subliming solid control rocket and examines its operating principles and important components, describes the experimental and analytical results of the development program, and discusses the equations and design procedures for the subliming solid control rocket. Author

N67-20332# Aeronautical Research Council (Gt. Brit.)
AN EXPERIMENTAL INVESTIGATION OF THE INFLUENCE OF BASE BLEED ON THE BASE DRAG OF VARIOUS PROPELLING NOZZLE CONFIGURATIONS
J. B. Roberts and G. T. Golesworthy London, Min. of Aviation, 1966 58 p refs Supersedes NGTE-R-259; ARC-26228
(ARC-CP-892; NGTE-R-259; ARC-26228) CFSTI: HC $3.00/MF $0.65

Various propelling nozzle configurations with all-internal expansion were tested in external flow over the range of Mach number 0.7 to 2.2, in order to determine the effect of base bleed (i.e. the injection of low energy secondary air) on base pressure. An overall efficiency is defined which enables the effectiveness of base bleed, as a means of reducing the base drag, to be assessed. The results indicate that with supersonic external flow base bleed generally tends to raise the level of base pressure, but no improvement in the overall efficiency is obtained. At subsonic external speeds, the secondary air has a negligible effect on base pressure. Author

29 SPACE RADIATION

Includes cosmic radiation; solar flares; solar radiation; and Van Allen radiation belts. For related information see also: 13 Geophysics; and 24 Physics, Atomic, Molecular, and Nuclear.

N67-19770# Cornell Univ., Ithaca, N. Y. Center for Radiophysics and Space Research.
THE MEASUREMENT OF SOLAR RADIATION AT 430 MEGACYCLES Final Report
Nov. 1966 12 p refs
(CRSR-256; AD-644356) CFSTI: HC $3.00/MF $0.65

A solar radio noise patrol was maintained through the International Geophysical Year. The main research effort was the study of the polarization of radio bursts from the sun. TAB

N67-19837# Harvard Coll. Observatory, Fort Davis, Tex.
STUDY OF THE RADIO FREQUENCY SPECTRUM OF THE SUN Final Report, 1 Oct. 1962–30 Jun. 1966
Alan Maxwell, comp. Jul. 1966 20 p refs
(Contract AF 19(628)-2370)
(AFCRL-66-533; AD-642103) CFSTI: HC $3.00/MF $0.65

The report surveys the research programs carried out under contracts between Harvard University and the U. S. Air Force. The contracts were written to promote research on the study of radio burst emissions from the sun, and to permit the construction of an 85-ft steerable paraboloid antenna and of a new laboratory. The report is divided into five sections: (1) Introduction, (2) New equipment, (3) Solar radio patrol, (4) Scientific results, (5) Future programs. Author (TAB)

N67-19862*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THE OSO 1 SOLAR NEUTRON EXPERIMENT
R. C. Kaifer (Calif. Univ., Livermore) and W. N. Hess Jan. 1967 22 p refs Submitted for publication
(NASA-TM-X-55713; X-640-67-28) CFSTI: HC $3.00/MF $0.65 CSCL 20H

BF_3 counters on OSO 1 were used to look for solar neutrons by trying to observe a diurnal variation in count rate. No effect was observed and an upper limit was placed on the solar neutron flux at the earth of $J_n < 2 \times 10^{-3}$ neut/cm^2-sec of 10 keV $< E_n < 10$ MeV for the period March to May 1962. No proton producing flares occurred during this time so the most obvious source of solar neutrons could not be studied. The emulsion experiment flown during this period which seemed to indicate solar neutrons has probably been misinterpreted. Author

N67-19883*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
CROSS-SECTION INFORMATION REQUIRED FOR THE CALCULATION OF THE PROPAGATION OF COSMIC RADIATION THROUGH INTERSTELLAR SPACE
D. V. Reames Feb. 1967 16 p refs
(NASA-TM-X-55715; X-611-67-88) CFSTI: HC $3.00/MF $0.65 CSCL 20H

The need for reliable cross section data is stressed to increase knowledge of interstellar space, the nature of the cosmic-ray source and of the mechanism by which the particles are accelerated. Reactions of interest involve protons of energy ≥ 10 MeV incident on target nuclei which are the most abundant constituents of the cosmic-ray flux. Target nuclei for which detailed energy-dependent fragmentation information is required include the stable isotopes of He, B, C, N, O, Ne, Mg, Si, Ca, and Fe. Reactions of greatest interest for cosmic-ray calculations are usually those that have the largest cross sections. Specific reactions include: the p+He^4 reaction, light nucleus production and loss, fragmentation of medium nuclei, F, Na, and Al and the fragmentation of nuclei with $9 \leq Z \leq 14$, and fragmentation of the iron-group nuclei. The need for data on total reaction cross sections and for He^4 induced reactions is also emphasized. S.P.

N67-19899* Aerospace Corp., El Segundo, Calif.
MODELS OF THE TRAPPED RADIATION ENVIRONMENT. VOLUME III: ELECTRONS AT SYNCHRONOUS ALTITUDES
James I. Vette, Antonio B. Lucero, and Jon A. Wright Washington, NASA, 1967 111 p refs
(NASA Order W-11683, Contract AF 04(695)-469)
(NASA-SP-3024) CFSTI: $3.00 CSCL 20H

In order to produce the trapped electron environment in sufficient detail, data was examined from particle detectors flown on Imp A, OGO A, ERS-17, and Explorers 6, 12, and 14. The model environment is confined to $L = 6.6$; B/B_o and local time variations as well as the energy spectrum are presented. Time variations are discussed in terms of a solar cycle variation, occasional 27-day variations, and in a completely statistical way. Since the elliptical satellites sample the $L = 6.6$ shell twice each orbit, the time between samples varies from three hours up to four days. It is shown that if a large number of these samples are treated as independent events, the logarithm of the flux displays a Gaussian distribution in which the standard deviation increases with energy. The construction of the model is discussed and graphical and analytical representations are given. R.N.A.

N67-20011*# Pennsylvania State Univ., University Park. Ionosphere Research Lab.
AN INVESTIGATION OF PARTICLE PENETRATION INTO THE MAGNETOSPHERE
T. E. Stevenson 10 Feb. 1967 92 p refs
(Grant NsG-134-61)
(NASA-CR-82997; SR-289) CFSTI: HC $3.00/MF $0.65 CSCL 20H

A theoretical investigation is made of the trajectory of a solitary charged particle which emanates from free space and is incident at the boundary of an idealized magnetic field. It is shown that reflection always occurs when a charged particle is incident near the equatorial boundary of a static terminated dipole field. Consequently, the Lorentz force equation and Newton's second law are used in an attempt to deduce some static and temporal, non-dipolar magnetic field variations required for deep penetration; emphasis is put on the case where the magnetic field gradient is perpendicular to the boundary. Analog simulation and first order theory are then used to demonstrate that a charged particle may enter and penetrate deep within a magnetic field when the magnetic field gradient is not perpendicular to the boundary of the field. Author

N67-20341*# Naval School of Aviation Medicine, Pensacola, Fla.
LINEAR ENERGY TRANSFER SPECTRA AND DOSE EQUIVALENTS OF GALACTIC RADIATION EXPOSURE IN SPACE
Hermann J. Schaefer 9 Dec. 1966 17 p refs Joint Rept. with NASA
(NASA Order R-75)
(NASA-CR-82999; NAMI-987) CFSTI: HC $3.00/MF $0.65 CSCL 20H

In assessing the astronaut's exposure from galactic cosmic rays on space missions of long duration conversion of absorbed doses to dose equivalents is required. Since a large part of the dose contribution from heavy primaries is produced at Linear Energy Transfer (LET) values beyond the range for which radiobiological data are available, it seems preferable to analyze the LET distributions themselves and to compare them to standard X-rays rather than to assume arbitrary values for the Relative Biological Effectiveness (RBE). The local LET distributions in tissue are found to be extremely skewed, with a large maximum at the relativistic minimum LET. Lined up on the LET scale, they cover the very wide interval from 0.18 to 2790 keV/micron T as compared to an interval from 0.4 to 35 keV/micron T for standard X-rays. Applying the RBE formula and a saturation value of 10 leads to a grand mean RBE of 1.82 for the total absorbed dose of 13 millirads/24 hours from primaries. Author

N67-20350# Royal Aircraft Establishment, Farnborough (England).
SURVEILLANCE OF SOLAR ACTIVITY FROM OPTICAL OBSERVATIONS OF SATELLITES [SURVEILLANCE DE L'ACTIVITE SOLAIRE A PARTIR DES OBSERVATIONS OPTIQUES DE SATELLITES]
F. Barlier, J. P. Chassaing, and P. Muller Oct. 1966 14 p refs Transl. into ENGLISH from French
(RAE-LIB-TRANS-1188) CFSTI: HC $3.00/MF $0.65

The paper describes a method of reducing visual observations of satellites, taking account of earlier ephemerides, which enables sudden variations in density at heights between 150 and 350 km to be determined. This method has made it possible for variations of 5–10% in density, since September 1965, to be correlated with solar events. The time of the event can be determined with an accuracy better than one day, and to within a few hours in some cases. Author

N67-20378*# California Univ., Berkeley. Dept. of Physics.
TEMPORAL AND SPECTRAL FEATURES OF AN INTENSE AURORAL ZONE X-RAY EVENT IN THE 4–5 SECOND PERIOD RANGE
R. R. Brown and R. A. Weir [1966] 20 p refs
(Grant NGR-05-003-096)
(NASA-CR-82984) CFSTI: HC $3.00/MF $0.65 CSCL 20H

In the magnetic activity following the September 2, 1966 PCA event, an intense auroral zone X-ray pulsation event was observed in the 4- to 5-sec period range. Comparison of this event with the temporal features of micropulsations in the same period range does not support the suggestion that pulsating electron precipitation arises from processes directly involving micropulsation fields. Author

N67-20379*# California Univ., Berkeley. Dept. of Physics.
AURORAL ZONE ELECTRON PRECIPITATION ACCOMPANYING A SUDDEN IMPULSE IN THE GEOMAGNETIC FIELD
R. R. Brown [1967] 14 p refs
(Grants NGR-05-003-096; AF-AFOSR-331-65)
(NASA-CR-82982) CFSTI: HC $3.00/MF $0.65 CSCL 20H

Balloon observations of strong, transient magnetic disturbances were examined to determine what forms of electron precipitation occur, and the data are graphed. The bremsstrahlung found accompanying a sudden impulse of 955 γ in H indicates that the X-ray fluxes were soft, with e-folding energy $E_0 \approx 13$ keV beyond the low energy portion strongly affected by atmospheric absorption, and relatively unstructured in time. N.E.N.

30 SPACE SCIENCES

Includes astronomy and astrophysics; cosmology; lunar and planetary flight and exploration; and theoretical analysis of orbit and trajectory. For related information see also: 11 Facilities, Research and Support; and 31 Space Vehicles.

N67-19381* Bendix Corp., Ann Arbor, Mich. Aerospace Systems Div.
LUNAR SURFACE MOBILITY SYSTEMS COMPARISON AND EVOLUTION (MOBEV), VOLUME II, BOOK 1: MOLEM, MOCOM, MOCAN, PART 2:
Nov. 1966 60 p refs
(Contract NAS8-20334)
(NASA-CR-82752; BSR-1428, V. II, Bk. I, Pt. 2) CFSTI: HC $3.00 CSCL 22A

The resource data for MOLEM, MOCOM and MOCAN have been prepared in response to Phase I, of the Mobility Systems Comparison and Evolution Study. The assumptions used in preparing resource data, cost breakdowns for each vehicle, schedules, funding curves, and learning curves required for each of the three vehicles studied in this task have been included. Costs for all vehicle concepts have been estimated against a common set of ground rules. For this study it has been assumed that the basic cabin shell for the LM, command module, and CAN are obtained GFE. The facilities requirements, GSE requirements, and test articles are the same for all three vehicles and these descriptions have been prepared and are applicable to all three vehicles. Author

N67-19382* Bendix Corp., Ann Arbor, Mich. Aerospace Systems Div.
LUNAR SURFACE MOBILITY SYSTEMS COMPARISON AND EVOLUTION (MOBEV), VOLUME II, BOOK 2: MISSION ANALYSIS
Nov. 1966 98 p refs
(Contract NAS8-20334)
(NASA-CR-82751; BSR-1428, Vol. II, Bk. 2) CFSTI: HC $3.00 CSCL 22A

Results are presented of a mission analysis performed on a number of lunar surface mobility systems. The analysis considered the range of missions and mission objectives with a view to establishing a spectrum of lunar vehicle requirements. Mission requirements are identified for manned flying vehicles, exploration roving vehicles, and base support vehicles. R.N.A.

N67-19383* Bendix Corp., Ann Arbor, Mich. Aerospace Systems Div.
LUNAR SURFACE MOBILITY SYSTEMS COMPARISON AND EVOLUTION (MOBEV), VOLUME II, BOOK 3: SYSTEMS ENGINEERING (LUNAR ROVING VEHICLES)
Nov. 1966 254 p refs
(Contract NAS8-20334)
(NASA-CR-82750; BSR-1428, Vol. II, Bk. 3) CFSTI: HC $3.00 CSCL 22A

System design approaches to the Exploration and Base Support Vehicles for the Task 3 Vehicles, and for the Design

Point Vehicles are presented; and data inputs are given. Systems analyses vehicle commonality studies for the astrionics, power system, thermal control, and life support concepts; and cabin/crew station and mobility types, were conducted. Subsystems analyses were conducted and parametric data are given for the astrionics, power, mobility, and life support subsystems. Vehicle sensitivity factors were studied. System trade-offs leading to the Design Point vehicle selection are given; and the results of a Lunar Roving Vehicle design survey are presented. L.S.

N67-19384* Bendix Corp., Ann Arbor, Mich. Aerospace Systems Div.
LUNAR SURFACE MOBILITY SYSTEMS COMPARISON AND EVOLUTION (MOBEV), VOLUME II. BOOK 4: SYSTEMS ENGINEERING (LUNAR FLYING VEHICLES)
Nov. 1966 85 p refs
(Contract NAS8-20334)
(NASA-CR-82748; BSR-1428, Vol. II, Bk. 5) CFSTI: HC $3.00 CSCL 22A

Results are presented of engineering studies conducted on lunar flying vehicle systems. The study resulted in the design of 13 design point flying vehicles which fulfill the spectrum of anticipated mission requirements of lunar exploration through 1980. They include one- two-, and three-man vehicles to perform rescue rescue and exploration functions. Their capabilities vary from carrying one man for 8 km to three men for 800 km, and two to three man return-to-orbit. They study also included analyses of vehicle propulsion system, navigation and guidance system, refueling, human performance requirements, crew safety, and mission success and failure. R.N.A.

N67-19385* Bendix Corp., Ann Arbor, Mich. Aerospace Systems Div.
LUNAR SURFACE MOBILITY SYSTEMS COMPARISON AND EVOLUTION (MOBEV), VOLUME II. BOOK 5 RESOURCE PLANNING Final Report
Nov. 1966 95 p refs
(Contract NAS8-20334)
(NASA-CR-82747; BSR-1428, Vol. II, Bk. 5) CFSTI: HC $3.00 CSCL 22A

Resource data generated during the Lunar Surface Mobility Systems Comparison and Evolution MOBEV, study are classified into (1) Design Point Vehicle, DPV, resource data and (2) comparative resource data. DPV data include costs, schedules, funding, test articles, ground support equipment and facilities required for development of the DPVs. Tables summarizing the DPV data generated, are given. The presentation of the comparative data provides a breakdown of each DPV by development element and establishes the effect on cost and schedule due to prior development. Tables summarizing the development element costs for all DPVs (roving and flying vehicles) from which comparative costs are generated are also given. Comparative schedule data are shown. Author

N67-19386* Bendix Corp., Ann Arbor, Mich. Aerospace Systems Div.
LUNAR SURFACE MOBILITY SYSTEMS COMPARISON AND EVOLUTION (MOBEV), VOLUME II, BOOK 6: EVOLUTION METHODOLOGY DEVELOPMENT Final Report
Nov. 1966 135 p refs
(Contract NAS8-20334)
(NASA-CR-82749; BSR-1428, Vol. II, Bk. 6) CFSTI: HC $3.00 CSCL 22A

A mobility evolution selection methodology pertinent to lunar surface mobility systems required during the coming decade was developed. The approach, logic, computer implementation, and other factors related to the development and utilization of the methodology are presented. The methodology is shown to be a useful tool to the planner in planning lunar mobility systems on a long-range basis and will aid him in altering and updating lunar mobility systems plans to reflect changes in funds available, technology, and knowledge of the lunar environment. Many subsidiary types of information are available from the methodology. The present capacity of the computer program, i.e., 50 vehicles in the library and up to 20 missions per run, is sufficient for the intended use of the program. The use of direct comparison for generating vehicle costs is satisfactory for the intended use. Some improvements can be made in this area and they are discussed. The use of approximation methods in computing vehicle expendables is not as accurate as may be desired. Recommended improvements are given. R.N.A.

N67-19387* Bendix Corp., Ann Arbor, Mich. Aerospace Systems Div.
LUNAR SURFACE MOBILITY SYSTEMS COMPARISON AND EVOLUTION (MOBEV), VOLUME II, BOOK 7: EVOLUTION METHODOLOGY USER'S MANUAL Final Report
Nov. 1966 203 p refs
(Contract NAS8-20334)
(NASA-CR-82746; BSR-1428, Vol. II, Bk. 7) CFSTI: HC $3.00 CSCL 22A

A detailed explanation of the use of the evolution methodology computer program is presented. The overall program and its logic are described followed by a detailed discussion of its input requirements and available outputs. Applications of the program in planning lunar surface exploration are covered both from the large scale viewpoint involving exploration programs comprised of up to 20 missions, and from a smaller more restricted viewpoint involving, for example, vehicle/mission trade-offs. The appendices contain symbols used in the logic flow charts, term definitions, detailed flow charts, technical data used in the program pertaining to the design point vehicles, and associated cost data. R.N.A.

N67-19388* Bendix Corp., Ann Arbor, Mich. Aerospace Systems Div.
LUNAR SURFACE MOBILITY SYSTEMS COMPARISON AND EVOLUTION (MOBEV). VOLUME I: SUMMARY
Nov. 1966 Nov. 1966 65 p refs
(Contract NAS8-20334)
(NASA-CR-82744; BSR-1428, Vol. I) CFSTI: HC $3.00 CSCL CSCL 22A

This study was conducted to develop a spectrum of lunar surface mobility systems concepts adequate to meet lunar exploration program mission requirements in the coming decade, and to develop a methodology to allow rapid and complete response to a wide variety of program planning problems. A spacecraft derivative study was conducted to prepare vehicle conceptual designs derived from existing Apollo spacecraft, including the Apollo Lunar Module, the Apollo Command Module, and the Multi-Mission Module. A mission analysis and system engineering study was made to provide mission requirements, guidelines, and constraints resulting in the definition of a mobility spectrum. This spectrum was compared with existing concepts and mobility gaps requiring further concept efforts were identified. Conceptual designs were made for all spectrum vehicles, the resulting systems analyzed, and a final set of design point vehicles were selected. A summary is given of the characteristics of the roving and flying vehicles designated as design points. R.N.A.

N67-19401*# Smithsonian Astrophysical Observatory, Cambridge, Mass.
PUBLICATION OF ORBITS DERIVED FROM PHOTOREDUCED BAKER-NUNN OBSERVATIONS

E. M. Gaposchkin 12 Dec. 1966 19 p refs
(Grant NsG-87-60)
(NASA-CR-82799; SAO Special Rept.-232) CFSTI: HC $3.00/MF $0.65 CSCL 22C

Precise orbital information has been computed using various numerical values for the geophysical constants. This report details the numerical values of the constants used. The further reports of orbital data will include the same relevant information. Author

N67-19402*# Smithsonian Astrophysical Observatory, Cambridge, Mass.
LUNISOLAR PERTURBATIONS WITH SHORT PERIODS
Yoshihde Kozai 20 Dec. 1966 31 p refs
(Grant NsG-87-60)
(NASA-CR-82798; SAO Special Rept.-235) CFSTI: HC $3.00/MF $0.65 CSCL 22C

In this paper lunisolar short-periodic perturbations and lunar perturbations that depend on the lunar mean longitude are given insofar as their amplitudes in the expressions of satellite orbital elements are larger than 10^{-7} Author

N67-19415*# Smithsonian Astrophysical Observatory, Cambridge, Mass.
NOTE ON EXPRESSIONS FOR SECOND-ORDER SHORT-PERIODIC PERTURBATIONS
Yoshihide Kozai 16 Dec. 1966 13 p refs
(Grant NsG-87-60)
(NASA-CR-082797; SAO Special Rept.-234) CFSTI: HC $3.00/MF $0.65 CSCL 22A

Expressions for second-order short-periodic perturbations for satellite motion are derived by assuming that $J_4 = -1.4\ J^2$. The expressions consist of terms for which amplitudes are larger than 10^{-7} when the parameter of the ellipse is equal to the equatorial radius of the earth and the eccentricity is 0.15. The expressions for the J_3 term are also given. Author

N67-19505*# Geological Survey, Washington, D. C.
ELECTRON MICROSCOPY OF MICROMETEORITES COLLECTED ON THE 1965 LUSTER EXPERIMENT
M. H. Carr and H. J. Gabe *In its* Astrogeol. Studies, Pt. C Oct. 1966 p 55–65 refs (See N67-19501 09-13) CFSTI: HC $3.00/MF $0.65

Analysis of extraterrestrial material on collectors specifically designed for electron microscope usage is reported for the sounding rocket payload launched in 1965 as part of the Luster program to recover and examine micrometeorites from the upper atmosphere. Far less material than anticipated was collected; and no evidence of high velocity impact was found in the six particles of possible extraterrestrial origin found in the 2×10^{-1} cm^2 collection surface. Sample preparation and contamination control are discussed. Preliminary examination indicated that Cu or CuO from the copper mesh was the principal contaminant in the collectors; submicron particles were seen along the edges of some of the screen openings, but not in the center. Distinguishing the particles from the contaminants present is considered to be extremely difficult, if not impossible. M.W.R.

N67-19535 Defence Research Board, Ottawa (Ontario).
EXPLORATION OF THE TERRESTRIAL MAGNETOSPHERE IN THE REGION OF THE RADIATION BELT (3–6 Re), FEBRUARY TO APRIL 1964. EXPLORATION BY ELEKTRON SATELLITES OF TERRESTRIAL MAGNETOSPHERE AT DISTANCE 7-11.7 EARTH RADII
Sh. Sh. Dolginov, Ye. G. Yershenko, and L. N. Zhuzgov May 1966 35 p refs Transl. into ENGLISH from Issled. Kosmich. Prostranstva, Tr. (Moscow), 1965 p 342–367
(T-455-R) CFSTI: HC $3.00

CONTENTS:

1. EXPLORATION OF THE TERRESTRIAL MAGNETOSPHERE IN THE REGION OF THE RADIATION BELT (3-6R_e). FEBURARY TO APRIL 1964 Sh. Sh. Dolginov, Ye. G. Yeroshenko, and L. N. Zhuzgov p 1–13 refs (See N67-19536 09-30)
2. EXPLORATION BY ELEKTRON SATELLITES OF TERRESTRIAL MAGNETOSPHERE AT DISTANCE 7-11.7 EARTH RADII Ye. G. Yeroshenko p 15–23 refs (See N67-19537 09-30)

N67-19536 Defence Research Board, Ottawa (Ontario).
EXPLORATION OF THE TERRESTRIAL MAGNETOSPHERE IN THE REGION OF THE RADIATION BELT (3–6 R_e), FEBRUARY TO APRIL 1964
Sh. Sh. Dolginov, Ye. G. Yeroshenko, and L. N. Zhuzgov *In its* Exploration of the Terrest. Magnetosphere in the Reg. of the Radiation Belt (3–6 R_e). Feb.–Apr. 1964 May 1966 p 1–13 refs (See N67-19535 09-30) CFSTI: HC $3.00

Scalar values of the T field are analyzed from the magnetosphere measurements of the Elektron II satellite. The measurements were made by two 3-component magnetometers with respective scale ranges of $\pm 1200\gamma$ and $\pm 120\gamma$ in each component. Orbit and meteorological characteristics of Elektron II are presented, and the character of magnetometric information is discussed. Magnetic measurement data from the outer radiation belt region are graphed, and characteristics of the radiation belt magnetic field are examined. It is concluded that these measurements testify to the existence of a quiet-day external magnetic field that is due to protons and electrons of the radiation belts. A.G.O.

N67-19537 Defence Research Board, Ottawa (Ontario).
EXPLORATION BY ELEKTRON SATELLITES OF TERRESTRIAL MAGNETOSPHERE AT DISTANCE 7–11.7 EARTH RADII
Ye. G. Yeroshenko *In its* Exploration of the Terrest. Magnetosphere in the Reg. of the Radiation Belt (3–6 R_e). Feb.–Apr. 1964 May 1966 p 15–23 refs (See N67-19535 09-30) CFSTI: HC $3.00

The results of magnetic measurements in the outer terrestrial magnetosphere from satellites Elekron II and Elektron IV are presented. Consideration is given to orbital data, the general character of magnetometric information, field variability on magnetically quiet days, field variability on magnetically disturbed days, magnetic storms, and data on the topology and morphology of the magnetosphere boundary region. Also included is a comparison of the satellite magnetograms with ground data. A.G.O.

N67-19539# Manchester Univ., Macclesfield (England). Nuffield Radio Astronomy Labs.
OBSERVATIONS OF GALACTIC AND EXTRA-GALACTIC EMISSION AT 408 Mc/s. THE DETERMINATION OF THE ACCURATE POSITIONS OF RADIO SOURCES BY THE LUNAR OCCULATATION TECHNIQUE. OBSERVATIONS OF EMISSION FROM FLARE STARS Progress Report, Apr.–Jun. 1966
C. G. T. Haslam, M. J. S. Quigley, A. G. Lyne, and A. C. B. Lovell Jun. 1966 5 p
(Contract N62558-3928)
(PR-3; AD-644160) CFSTI: HC $3.00/MF $0.65

Consideration is given to the programming system which is being developed to analyze the observation data. It is reported that the survey data tapes have been edited and split into lengths corresponding to the data collected for each four hour observing period of the fifty-nine survey days. Work was also carried out on receivers at 408 Mc/s to improve their stability and sensitivity. A.G.O.

N67-19543# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

ON TWILIGHT INVESTIGATIONS OF PLANETARY ATMOSPHERES FROM SPACE SHIPS

G. V. Rozenberg 17 Jun. 1966 20 p ref Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Fiz. Atmosfery i Okeana (USSR), v. 1, no. 4, 1965 p 377–385

(FTD-MT-65-400; TT-66-62496; AD-640725) CFSTI: HC $3.00/MF $0.65

Translation of Russian research: On Twilight Investigations of Planetary Atmospheres from Space Ships. TAB

N67-19650*# American Science and Engineering, Inc., Cambridge, Mass.

ANALYSIS OF SOUNDING ROCKET DATA REGARDING CELESTIAL X-RAY SOURCES Final Report

H. Gursky, R. Giacconi, P. Gorenstein, and J. R. Waters Sep. 1966 51 p refs

(Contract NASw-1396)

(NASA-CR-80112; ASE-1408 CFSTI: HC $3.00/MF $0.65 CSCL 22A

CONTENTS:

1. A MEASUREMENT OF THE ANGULAR SIZE OF THE X-RAY SOURCE Sco X-1 H. Gursky, R. Giacconi, P. Gorenstein, J. R. Waters, M. Oda et al 5 p refs (See N67-19651 09-30)

2. X-RAY EMISSION FROM Sco X-1 O. P. Manley 5 p refs (See N67-19652 09-30)

3. A MEASUREMENT OF THE LOCATION OF THE X-RAY SOURCE Sco X-1 H. Gursky, R. Giacconi, P. Gorenstein, J. R. Waters, M. Oda et al 15 p refs (See N67-19653 09-30)

4. ON THE OPTICAL IDENTIFICATION OF Sco X-1 A. R. Sandage, P. Osmer, R. Giaconni, P. Gorenstein, H. Gursky et al 16 p refs (See N67-19654 09-30)

N67-19651* American Science and Engineering, Inc., Cambridge, Mass.

A MEASUREMENT OF THE ANGULAR SIZE OF THE X-RAY SOURCE Sco X-1

H. Gursky, R. Giacconi, P. Gorenstein, J. R. Waters, M. Oda et al 20 Apr. 1966 *In its* Anal. of Sounding Rocket Data Regarding Celestial X-ray Sources Sep. 1966 5 p refs Repr. from Astrophys. J., v. 144, no. 3, Jun. 1966 Prepared in cooperation with MIT (See N67-19650 09-30) CFSTI: HC $3.00

(Grant NsG-386; Contracts NASw-1284; AT(30-1)-2098)

In a study of celestial X-ray sources, preliminary high-angular-resolution sounding rocket observations of Sco X-1, the strong X-ray source in Scorpio, are reviewed. The upper limit on the angular size of Sco X-1 was considered to have important implications as to the nature and physical characteristics of the emitting object. The supernova remnant theory is rejected, while the existence of a new class of celestial objects that are powerful X-ray emitters appears to be established. These are not associated with supernovae and, if observable, appear in visible light as starlike objects. R.Ll.

N67-19652*# American Science and Engineering, Inc., Cambridge, Mass.

X-RAY EMISSION FROM Sco X-1

Oscar P. Manley 20 Apr. 1966 *In its* Anal. of Sounding Rocket Data Regarding Celestial X-ray Sources Sep. 1966 5 p refs Repr. from Astrophys. J., v. 144, no. 3, Jun. 1966 (See N67-19650 09-30) CFSTI: HC $3.00/MF $0.65

(Contract NASw-1284)

Consideration is given to a new class of celestial objects, (extars) and the possibility that they are members of the Galaxy. In a study of X-ray emission from Sco X-1, of the Scorpio Constellation, an hypothesis is reviewed which disproves the estimates of cosmological distances for quasi-stellar sources. It is derived from the requirement that electron energy losses by inverse Compton effect cannot exceed losses by synchrotron emission, and the assumption that the size of the source is limited by the lifetime of the radiating electrons. A brief mathematical exposition is presented and includes a formula for estimating the angular size of the extar. Graphics indicate a normalized synchrotron spectrum for a flat electron energy distribution, a synchrotron spectrum fit to X-ray spectrum from Sco X-1, and a synchrotron spectrum fit to high-energy X-ray emission from Crab Nebula. R.Ll.

N67-19653*# American Science and Engineering, Inc., Cambridge, Mass.

A MEASUREMENT OF THE LOCATION OF THE X-RAY SOURCE Sco X-1

H. Gursky, R. Giacconi, P. Gorenstein, J. R. Waters, M. Oda et al *In its* Anal. of Sounding Rocket Data Regarding Celestial X-ray Sources Sep. 1966 15 p refs Submitted for publication Prepared in cooperation with MIT (See N67-19650 09-30) CFSTI: HC $3.00/MF $0.65

(Grant NsG-386; Contracts NASw-1284; AT(30-1)-2098)

The location of Sco X-1, the strong X-ray source in Scorpio, was measured with a precision of about 1 arc minute. The stabilized Aerobee sounding rocket was equipped with an attitude control system, and five individual detectors behind each collimator used to detect the transmitted X-rays. The location of Sco X-1 in this experiment is at least 30 arc minutes away from any of the previously reported location, but this is not considered a serious disagreement with previous data. The significance of this measurement is that it affords the possibility of an unequivocal optical identification of the visible and radio counterparts of the Sco X-1 source. R.Ll.

N67-19654*# American Science and Engineering, Inc., Cambridge, Mass.

ON THE OPTICAL IDENTIFICATION OF Sco X-1

A. R. Sandage, P. Osmer (Mount Wilson Obs.), R. Giacconi, P. Gorenstein, H. Gursky et al *In its* Anal. of Sounding Rocket Data Regarding Celestial X-ray Sources Sep. 1966 16 p refs Submitted for publication (See N67-19650 09-30) CFSTI: HC $3.00/MF $0.65

(Grant NsG-386; Contracts NASw-1284; AT(30-1)-2098)

Summary data are reviewed on the optical search and identification of Sco X-1, of the Scorpio Constellation. The object cited is considered to have certain of the properties of an old nova even though its spectral characteristics cannot be identified with any one class of old novae. The most striking characteristic of the object is that it emits X-rays in copious quantity. The energy emitted in the 1 to 10A region is about one thousand times greater than that emitted in visible light. The observed visual magnitude is close to the value computed by extrapolating the energy distribution from the observed range of 1 to 10A into the optical region with the exponential spectrum of bremsstrahlung emission from an optically thin gas. This implies that the bulk of the observed emission in the visible light continuum can be accounted for by the process which we have assumed to give rise to the observed X-rays. R.Ll.

N67-19673# Lowell Observatory, Flagstaff, Ariz.

MULTICOLOR PHOTOELECTRIC PHOTOMETRY OF THE NUCLEI OF GALAXIES Final Report

William G. Tifft 1 Aug. 1966 33 p refs

(Grant Nonr(G)-00026-64)

(A66-4a; AD-640756) CFSTI: HC $3.00/MF $0.65

Sixty-four galaxies, including forty-four in the region of the Virgo Cluster have been observed photoelectrically in four colors. Five apertures from 10 to 65 arc seconds were used for

most of the systems. Four basic types of galaxies are recognized among both spirals and ellipticals: (1) normal systems which become smoothly redder toward the center; (2) relatively blue galaxies with otherwise normal color curves; (3) galaxies with abnormally red nuclei, and (4) galaxies with strong blue nuclei. Author (TAB)

N67-19677# Hughes Research Labs., Malibu, Calif.
TEMPERATURE MEASUREMENTS ON ELECTRON AND ION BEAMS
H. Heil and B. Scott Aug. 1966 41 p refs
(Contract AF 19(628)-4297)
(AFCRL-66-769; SR-2; AD-643532) CFSTI: HC $3.00/MF $0.65

The retarding potential method produced temperature measurement accuracies which are comparable to or better than those possible with the best pyrometers or thermocouples. The method is limited to a close-spaced planar diode, with a collimating magnetic field to avoid nonaxial forces. In addition, the complete hemisphere of angles in the distribution must contribute in order to yield the simple current-voltage relation i (v) = e to the v power; (v < 0). In contrast, the total energy distribution function for a Maxwellian reads i (v) = (1-v) e to the v power. It may be measured with an energy spectrometer which is sensitive to the total energy only. Such an instrument is described. In this case the source and spectrometer may be far apart. On its way to the spectrometer the beam may be accelerated, focused, or generally subjected to nonaxial forces. Furthermore, completeness of the angular distribution is not required. A graphical method for accurate temperature determination from a recorded energy spectrum is described. As examples, the electron spectrum from a vidicon gun with oxide coated cathode and the ion spectrum from the plasma of a plane parallel cesium diode are shown. Author (TAB)

N67-19786# Block Engineering, Inc., Cambridge, Mass.
RESEARCH DIRECTED TOWARD THE PRODUCTION OF AN ATLAS OF INFRARED CELESTIAL BACKGROUNDS Final Report, 1 May 1963–1 Oct. 1966
Philip W. Davis Oct. 1966 52 p
(Contract AF 19(628)-3231)
(AFCRL-66-716; AD-643234) CFSTI: HC $3.00/MF $0.65

The report describes the research and development performed toward the development and testing of equipment and techniques for the production of an atlas of infrared celestial backgrounds. Instrumentation developed during the course of the contract includes: (1) 21 in. f/2.3 Newtonian telescope; (2) 5 in refracting telescope; (3) Multichannel infrared photometer; (4) Photomultiplier photometer. Author (TAB)

N67-19800# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.
ON THE MOTION AND STABILITY OF A MULTIPLE CONNECTED GRAVITY-GRADIENT SATELLITE WITH PASSIVE DAMPING
Peter M. Bainum (Ph.D. Thesis—Catholic Univ. of Am.) Jan. 1967 148 p refs
(Contract NOw-62-0604-c)
(TG-872; AD-644692) CFSTI: HC $3.00/MF $0.65

A generalized analytical method is formulated for studying the motion and stability of a gravity-gradient satellite inertially connected with one or two gimballed damping booms which are assumed to be hinged at or very near the system center of mass; it is the relative motion between these connected bodies which affords a means of dissipating the librational energy. (An experimental satellite, called DODGE, employing the single damper boom will be launched in 1967). The equations of rotational motion are derived using Lagranges general formulation, where the system center of mass is assumed to be in a circular orbit. Included are the effects of the gravitational restoring torques, the dissipative torques, and the gyroscopic torques that result from the coupling between the orbital angular velocity and the rotational motion in pitch-roll-yaw referenced to a local vertical frame. The equations are then linearized under suitable small angle assumptions to consider the motion and stability in the vicinity of the equilibrium point. The stability of the linear system is analyzed using both the methods of Routh-Hurwitz and Lyapunovs second or direct method. An extension of the linearized theory considers the stability of a particular nonlinear system, and examines the capture from zero inertial angular rate. Expressions are developed for the thermal deflections of the extendible booms and the torques resulting from the interaction of solar radiation forces with the bent booms. The stability criterion developed for the linear system is extended to consider the (assumed) continuously acting solar torques. This is achieved with an application of Malkins theorem. Author (TAB)

N67-19836# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.
THREE-AXIS STABILIZATION OF A DUMBBELL SATELLITE BY A SMALL CONSTANT-SPEED ROTOR
Vincent L. Pisacane Oct. 1966 26 p refs
(Contract NOw-62-0604-c)
(TG-855; AD-644693) CFSTI: HC $3.00/MF $0.65

The paper constitutes a preliminary investigation of the feasibility of achieving three-axis stabilization of a dumbbell spacecraft by the use of a small constant-speed rotor. Linearized equations of motion of the system, which provide a design formula for the rotor characteristics, are given. The results of a digital simulation of the nonlinear differential equations of motion of a spacecraft in a sun-synchronous orbit with passive damping and appropriate disturbing torques are also presented. The results indicate that the use of a small constant-speed rotor to achieve yaw stability is a very effective technique. This semi-passive stabilization system should weigh less and provide more accurate stabilization than a configuration with an unsymmetrical inertia ellipsoid. In addition, important roll and yaw damping should be obtained by supporting the rotor housing with an energy dissipator. Author (TAB)

N67-19882*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
ORBITAL PREDICTION AND DIFFERENTIAL CORRECTION USING VINTI'S SPHEROIDAL THEORY FOR ARTIFICIAL SATELLITES
Harvey Walden Washington, NASA, Mar. 1967 90 p refs
(NASA-TN-D-3803) CFSTI: HC $3.00/MF $0.65 CSCL 22C

The spheroidal theory developed by Vinti for determining the orbit of an artificial satellite of an oblate planet is presented in algorithmic form, in which empirically derived initial conditions are used to obtain the coordinate and velocity components of an unretarded satellite at any time. A differential orbit improvement method using observational data is described. This method produces a mean set of orbital elements by an iterated least squares fitting of the equations of condition. The results of preliminary applications of the orbit generator and differential correction to two artificial satellites of the earth, through use of a high speed digital electronic computer, are shown in tabular and graphical form. Author

N67-19903*# National Aeronautics and Space Administration, Manned Spacecraft Center, Houston, Tex.
COST EFFECTIVENESS: INCENTIVE STIMULANT FOR FUTURE SPACECRAFT PROGRAMS
Edward D. Lupo 4 Nov. 1965 28 p
(NASA-TM-X-59453) CFSTI: HC $3.00/MF $0.65 CSCL 22A

The contribution that operations research techniques can make to the effective operation of future spacecraft programs is

discussed. A detailed study was undertaken to investigate the advantages and disadvantages of the various proposed concepts for earth orbital experimentation. Part of the result of this investigation was concerned with a gross level analysis of the effect of the major system parameters of the concepts on the cost effectiveness of the total program. Major steps taken and the major conclusions reached are outlined. It is shown that although the techniques of cost effectiveness analysis are not new, they are useful in aiding decision making. There is a growing emphasis in space program planning to use such techniques to eliminate uneconomical methods of mission accomplishment by applying the techniques at the program level. Even in the relative uncertainty and instability of planning for future manned space flight programs, the logic of cost effectiveness analysis can and will contribute significantly to economical spacecraft operations. R.N.A.

N67-19904*# Stanford Research Inst., Menlo Park, Calif.
CHEMICAL ORIGIN OF THE VENUSIAN CLOUDS Interim Report, 1 Oct. 1966–30 Jan. 1967
R. C. Robbins 24 Feb. 1967 12 p refs
(Contract NASr-49(25); SRI Proj. PAU-6128)
(NASA-CR-82960; IR-2) CFSTI: HC $3.00/MF $0.65 CSCL 03B

A laboratory study was made of chemical reactions which may be important in the atmosphere of Venus. It has been found that the reaction between excited hydrogen atoms and carbon monoxide yields intermediate radical and atom species which undergo rapid secondary reactions to produce water and organic compounds. The principal organic compounds formed are ethylene, formaldehyde, and glyoxal, all readily polymerizable substances. Since the reaction course proceeds in this fashion under laboratory conditions, with the formation of these reactive monomers, it is altogether possible that the same reactions and products are important in the high Venus atmospheres. Author

N67-19916*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
A TWO-VARIABLE ASYMPTOTIC SOLUTION FOR THREE-DIMENSIONAL SOLAR-POWERED, LOW-THRUST TRAJECTORIES IN THE VICINITY OF THE ECLIPTIC PLANE
P. Wesseling 15 Mar. 1967 24 p refs
(Contract NAS7-100)
(NASA-CR-82913; JPL-TR-32-1053) CFSTI: HC $3.00/MF $0.65 CSCL 22C

An approximate analytic solution is derived for the variables which describe a three-dimensional, solar-powered, heliocentric, low-thrust trajectory in the vicinity of the ecliptic plane. It consists of the first three terms of an asymptotic series, valid in the limit of vanishing thrust. To obtain an extended domain of validity, the two-variable method is used. Direction and magnitude of the thrust acceleration may change discontinuously at arbitrarily chosen instants. In the time-intervals between these instants, the direction of the thrust is constant with respect to the sun-spacecraft vector and the plane of the initial orbit, and the thrust acceleration is assumed to be inversely proportional to the square of the distance to the sun. The actual variation of the thrust acceleration may be approximated by step-by-step changes in the constant of proportionality. The results are compared with numerical integrations of the equations of motion. If the ratio of the thrust acceleration and the gravitational acceleration is less than 1/10, the difference between the results given by the approximate formulas and those to numerical integration is, at most, 1%. After 1.5 revolutions around the sun, no signs of growing errors could yet be discovered. It is concluded that the asymptotic series is a useful tool for the design of solar-powered, interplanetary, low-thrust trajectories. Author

N67-19931*# Melpar, Inc., Falls Church, Va. Space Systems Lab.
ANALYSIS OF ALL AVAILABLE ZODIACAL LIGHT OBSERVATIONS Final Report
R. S. Powell, P. D. Woodson, III, M. A. Alexander, R. R. Circle, A. G. Konheim et al Feb. 1967 66 p refs
(Contract NASw-1206)
(NASA-CR-82936) CFSTI: HC $3.00/MF $0.65 CSCL 03B

A model of the interplanetary dust ensemble is derived which explains many of the inconsistencies in the zodiacal light observations. It is shown that the number density of particles is nearly independent of distance from the sun in the region between Mercury and Mars but is possibly zero beyond Mars. Further, it is shown that the size distribution of the interplanetary dust changes slightly with time and distance from the sun. Finally, it is shown that the ensemble consists of particles with radii less than 1.1 micron. A few larger particles certainly exist but they do not affect the zodiacal light. The electron density in the region beyond Mercury is arbitrary. Author

N67-19944*# Bendix Corp., Ann Arbor, Mich. Aerospace Systems Div.
LUNAR SURFACE MOBILITY SYSTEMS COMPARISON AND EVOLUTION (MOBEV). VOLUME III: RESEARCH AND TECHNOLOGY IMPLICATIONS
Nov. 1966 26 p
(Contract NAS8-20334)
(NASA-CR-82955; BSR-1428) CFSTI: HC $3.00/MF $0.65 CSCL 22A

Results obtained on the lunar surface mobility systems comparison and evolution study indicate that further efforts in certain areas of research and advanced technology would be desirable. The recommendations are summarized and listed under the following categories: (1) biotechnology, human factors, life support, and simulations; (2) electronics and controls for roving and flying vehicles; (3) materials, structures, insulation, and shielding; (4) radioisotope and Rankine power systems; and (5) propulsion and power generation. K.W.

N67-19958*# Douglas Aircraft Co., Inc., Santa Monica, Calif. Missile and Space Systems Div.
STUDY OF PARTICLES COLLECTED BY THE 1965 LUSTER ROCKET
N. N. Greenman, C. B. Gilpin, S. K. Asunmaa, and R. G. Ingersoll Nov. 1966 33 p refs
(Contract NASw-1401)
(NASA-CR-82941; DAC-59168) CFSTI: HC $3.00/MF $0.65 CSCL 22A

The Luster micrometeorite collecting rocket was successfully flown during the Leonid meteor shower and collected for 206 sec between altitudes of 63 and 144 km. The collector surface consisted of titanium, tungsten, and molybdenum electron microscope screens with substrates of silicon monoxide and shadow coats of nickel or indium. The objectives were to test, by heat annealing, whether radiation damage distinguished extraterrestrial from terrestrial particles; and to obtain flux, composition, and other data about micrometeorites. Heating tests were made on one group of 58 particles and on 2 individual particles. Only one particle showed possible radiation damage annealing, but it also showed some morphologic changes. It was concluded that all the particles could be contaminants and that more particles must be studied to establish whether radiation damage is a criterion for micrometeorites. However, the heat produced morphologic changes may prove important in distinguishing micrometeorites from contaminants. The flux observed, uncorrected for contaminants or scanning efficiency, is 0.3 particle/mm^2 of collector surface if the groups are counted as single particles, or 2 particles/mm^2 if every particle in the group is counted. Author

N67-19960* Douglas Aircraft Co., Inc., Santa Monica, Calif. Missile and Space Systems Div.

REPORT ON THE DEVELOPMENT OF THE MANNED ORBITAL RESEARCH LABORATORY (MORL) SYSTEM UTILIZATION POTENTIAL. TASK AREA I: ANALYSIS OF SPACE RELATED OBJECTIVES, BOOK 2

H. L. Wolbers Sep. 1965 239 p refs

(Contract NAS1-3612)

(NASA-CR-66283; SM-48808) CFSTI: $3.00 CSCL 22A

To provide assurance that foreseeable laboratory facility requirements were met, the baseline experiment program was expanded, and potential experiments were accumulated from existing documents. A number and title was established for each experiment, with a brief description of the research area included. These data bank summaries are categorized as: *space sciences*—astronomy/astrophysics, biological sciences, and physical sciences; *earth-oriented applications*—atmospheric science and technology, earth sciences and resources, and communications/navigation/traffic control; *space travel support*—biomedical-behavioral, advance technology and supporting research, extravehicular engineering activities, and operation techniques and advance mission spacecraft subsystems; and *DOD research and development support*. Each format includes (1) a measurement area title representative of all the experiments cross-referenced; (2) the purpose and methodology of the measurement area; (3) the references used in formulating the summary; and (4) a list of the type, quantity, weight, and volume of onboard test equipment, and equipment unique to a particular experiment. M.G.J.

N67-19999*# Lockheed Missiles and Space Co., Huntsville, Ala. Research and Engineering Center.

STABILITY STUDIES OF PERIODIC SOLUTIONS Final Report

Jan. 1967 76 p refs

(Contract NAS8-20323)

(NASA-CR-82921; LMSC/HREC-A783816; HREC-0323-1) CFSTI: HC $3.00/MF $0.65 CSCL 03C

The stability of periodic orbits of the restricted three-body problem is discussed. Available techniques are presented and the necessary background material is developed. The existence of periodic solutions of the restricted three-body problem is developed from first principles. Starting with Newton's gravitational law and equations of motion the proof is developed via the Lagrange and Hamilton equations of motion, existence theorem for differential equations, the two- and three-body problems. Author

N67-20017# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

APPLICATION OF THE METHOD OF EQUALIZATION OF OBSERVATIONS FOR EVALUATING THE POSITIONS OF AN ARTIFICIAL SATELLITE OF THE EARTH

A. A. Kiselev 18 Aug. 1966 16 p refs Transl. into ENGLISH from Iskusstv. Sputniki Zemli (Moscow), no. 32, 1963 p 16–24

(FTD-TT-65-2039; AD-644004) CFSTI: HC $3.00/MF $0.65

The objective evaluation of the precision of observations of artificial satellites of the earth is obtained ordinarily as a collateral product in the process of determining or improving the elements of the orbits of selected satellites. The respective computations are based on great series of observations carried out at different stations at different points of the earth's sphere over the course of an interval of time of the order of several weeks and in an extreme case, days. These series of observations can hardly be recognized as uniform. Lack of agreement in the data of observations and the theory under these conditions is reflected not only by actual, random, and systematic errors in the observations, but also by errors in the position of the stations of observations, imperfections in the theory, or real anomalies in the movement of the satellites, which can be especially notable in the case of low satellites. TAB

N67-20184# Aerospace Corp., El Segundo, Calif.

ON THE GRAVITATIONAL EXCITATION OF AN EXTENSIBLE DUMBBELL SATELLITE, 1 JANUARY 1966–1 OCTOBER 1966

V. Chobotov Nov. 1966 32 p refs

(Contract AF 04(695)-1001)

(TR-1001(2307)-4; SSD-TR-66-225; AD-644274) CFSTI: HC $3.00/MF $0.65

The nonlinear differential equations which describe the extensional motion of a freely spinning and gravitationally stabilized spring-mass system in the plane of an orbit are presented, linearized, and solved analytically and on a digital computer. The linearization leads to the Mathieu equation for the spinning system and to a set of two degree-of-freedom coupled equations for the gravitationally stabilized case. The solutions for the undamped systems indicate stable periodic and almost periodic oscillations characterized by beats. Author (TAB)

N67-20273*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

SOLAR PRESSURE PERTURBATIONS ON THE ORBIT OF A FLAT REFLECTOR

Scott Perrine *In its* Aero-Astrodyn. Res. Rev. No. 5 15 Oct. 1966 p 130–136 refs (See N67-20261 09-34)

Presented are the effects of solar pressure on a flat reflecting satellite. An equation for solar pressure is developed, and its effect on a two-dimensional orbital mechanics model is determined. Specific examples of 24-, 12-, and 6-hr period orbits are investigated. These orbits are, in general, shown to be perturbed into ellipses with constantly changing eccentricities, but with reasonably constant semi-major axes. Specific cases were found, however, where the eccentricity of the ellipses remained constant and the major axes remained oriented along the earth–sun line. Author

N67-20274*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

LUNAR SURFACE: AN INTERPRETATION BASED ON PHOTOGRAPHIC DATA FROM THE RUSSIAN LUNA IX AND UNITED STATES SURVEYOR I

Otha H. Vaughan *In its* Aero-Astrodyn. Res. Rev. No. 5 15 Oct. 1966 p 138–144 refs (See N67-20261 09-34)

Lunar surface implications are considered from photographic data provided by Luna IX and Surveyor I. The striking similarity of different lunar area terrain is pointed out, and some of the pitfalls in interpretations of a surface based on photographs alone are discussed. Based on the Lunar IX and Surveyor I data, a realistic model which represents the areas in which these two spacecraft landed is also presented. A.G.O.

N67-20282# European Space Research Organization, Paris (France).

SPACECRAFT ORBITS

G. E. Cook (RAE) Jul. 1966 51 p refs Presented at the ESRO Summer School, Oxford, 11–12 Aug. 1964

(ESRO-TM-26) CFSTI: HC $3.00/MF $0.65

The method of obtaining approximate trajectories of a space vehicle by means of a succession of two-body problems is discussed and illustrated for the case of a space vehicle in the earth–moon system. This sphere-of-influence concept can also be used for preliminary studies of interplanetary flight, and velocity requirements so obtained for two-impulse transfer from the earth's orbit to various planets are given. Equations of perturbed motion

for a planet or earth satellite are derived using the technique known as the variation of parameters. This is followed by an investigation of the effect of the earth's gravitational potential on a satellite orbit. The contraction of a satellite orbit under the influence of air drag is then considered and basic equations are derived to give the first-order effects. Finally, the luni–solar perturbations of earth satellites caused by gravitational effects and solar radiation pressure are investigated. Author (ESRO)

N67-20296# European Space Research Organization, Paris (France).
THE ACCURACY OF MAGNETIC ASPECT MEASUREMENTS ABOARD A SATELLITE: GEOMETRICAL CONSIDERATIONS CONSIDERATIONS
C. C. Kalweit (European Space Technol. Center, Noordwijk, Netherlands) Nov. 1966 37 p refs
(ESRO-TM-21) CFSTI: HC $3.00/MF $0.65

In the determination of the magnetic aspect aboard a satellite, errors occur due to inaccuracies of the measurement and also to the non-instantaneous sampling of the instrument outputs. The purpose of this paper is to study the angular aspect errors resulting from these system errors without discussing the measurement errors themselves. General formulae and numerical examples are given for the relation between error-angles, system errors and attitudes. As part of these geometrical considerations the deletion of the third magnetometer sensor is examined and found to be not permissible. Author (ESRO)

N67-20323 Royal Aircraft Establishment, Farnborough (England).
THE DYNAMIC MODEL OF PROP, A COMPUTER PROGRAM FOR THE REFINEMENT OF THE ORBITAL PARAMETERS OF AN EARTH SATELLITE
R. H. Merson Aug. 1966 31 p refs Presented at the COSPAR 7th Intern. Space Sci. Symp., Vienna, May 1966
(RAE-TR-66255) CFSTI: HC $3.00

Prop is the code name for a new orbit determination program written in Fortran for an Atlas computer. With certain minor modifications the program can also handle certain tracking network assessment problems and prediction problems. Prop is similar, in many respects, to the D.O.I. program of the Smithsonian Institution Astrophysical Observatory, which is based on the theory of Kozai. Prop, however, is capable of handling not only range and angle observations but also observations of range rate and angle rate, so that virtually all current types of ground-based satellite observations can be analysed. This paper is concerned mainly with extensions and modifications of Koxai's theory in respect of perturbations due to the gravity field of the earth. In particular, the long-periodic perturbation of the mean anomaly is derived, and compact formulae for perturbations due to zonal harmonics up to any order are presented in a form suitable for computation. Particular attention is paid to the removal of singularities at $e \approx 0$, $i \approx 0$ and to the pseudo-resonance at $i \approx 63°.4$. Author

N67-20347# Johns Hopkins Univ., Baltimore, Md. Astrophysics and Physical Meteorology Lab.
INFRARED BALLOON ASTRONOMY Final Report, 1 Aug. 1961–30 Jun. 1966
John Strong et al 1 Jul. 1966 302 p refs
(Contract AF 19(628)-4334)
(AFCRL-66-616; AD-643567) CFSTI: HC $3.00/MF $0.65

The report describes instrumentation used in a balloon gondola to make infrared astronomical studies of Venus with a telescope of 16 inches aperture at 16 miles altitude. With it, water vapor was discovered above the clouds in the Cytherean atmosphere; and ice was identified as the composition of the clouds themselves. Solutions to optical and spectroscopic problems, in connection with these scientific missions, are described. For the water vapor determination, a photomultiplier with S-1 photocathode, cooled by a dry ice refrigerator, was used behind the multiple exit slits (21) of a modified Ebert spectrometer. For the cloud determination, multiple indium arsenide detectors (3), similarly cooled, were focused on the exit focal plane of the spectrometer. Gratings served to disperse the spectrum. An aspheric mirror corrected aberration of the spherical primary mirror. An off-axis lens corrected residual aberrations in the spectrometer. The automatic acquisition and tracking, at altitude, using variable off-set angles, from the sun as the fiducial point, is considered both instrumentally, and as a navigation problem. Laboratory measures of the reflectivity of various candidate cloud materials are presented, with a description of equipment used. The scientific results are described in detail and some interpretations are given. Author (TAB)

31 SPACE VEHICLES

Includes launch vehicles; manned space capsules; clustered and multistage rockets; satellites; sounding rockets and probes; and operating problems. For basic research see: 30 Space Sciences. For related information see also: 28 Propulsion Systems; and 32 Structural Mechanics.

N67-19380* Bendix Corp., Ann Arbor, Mich. Aerospace Systems Div.
LUNAR SURFACE MOBILITY SYSTEMS COMPARISON AND EVOLUTION (MOBEV), VOLUME II, BOOK 1: MOLEM, MOCOM, MOCAN. PART I: TECHNICAL REPORT Final Report
Nov. 1966 145 p refs
(Contract NAS8-20334)
(NASA-CR-82753; BSR-1428, V. II, Bk. 1, Pt. 1) CFSTI: HC $3.00 CSCL 22B

The results of a study comparing and evaluating various lunar surface mobility systems are presented, including the lunar mobility systems derived from the Lunar Excursion Module (MOLEM), from the Apollo Command Module (MOCOM), and from the Multimission Module (MOCAN). The basic guideline for the conceptual designs was to retain as much of the existing spacecraft systems as possible, provided that the required performance is met and that the weight does not exceed 8500 lb. Each of the designs provides for a crew of two, and a scientific payload of 320 kg for a 14-day mission and a 400-km range. The stripped spacecraft definition, configuration, system design, mobility and performance capability, sensitivity, and human factors are discussed in detail for each of the systems. It was concluded that each of the concepts is technically feasible, in the case of MOCAN with degraded performance, and in the case of MOLEM with marginal cabin space. However, they do not offer any measurable advantages over a system which is designed specifically for mobility use. L.E.W.

N67-19857* Douglas Aircraft Co., Inc., Santa Monica, Calif. Missile and Space Systems Div.
REPORT ON THE DEVELOPMENT OF THE MANNED ORBITAL RESEARCH LABORATORY (MORL) SYSTEM UTILIZATION POTENTIAL. TASK AREA III: MORL CONCEPT RESPONSIVENESS ANALYSIS, BOOK 2
D. E. Charhut Nov. 1965 308 p
(Contract NAS1-3612)
(NASA-CR-66287; SM-48814) CFSTI: $3.00 CSCL 22B

The results of an analysis of a 48-hr period in the operational lifetime of the Manned Orbital Research Laboratory (MORL) are presented in detail. The 50° inclination, 200 n. mi. altitude orbital

mission was used. The study considered all on-board activities during the 48-hr interval and the corresponding ground support activities required to maintain the MORL in orbit and provide the necessary support for the experimental program. Measurement of the responsiveness of the baseline MORL system is accomplished by comparing system and subsystem capabilities to the requirements of the mission development plan. Operational requirements examined include: those associated with specific orbital characteristics, e.g., altitude and inclination; the corresponding environment, e.g., radiation and meteoroid intensities; the selection of mission vehicle elements; and a time-phased schedule for mission operations. Details are given on the mission characteristics, experiment program, flight crew activity analysis, experimental integration, subsystem accommodation, mission operations and support, and perturbation analyses. L.E.W.

N67-19859*# Douglas Aircraft Co., Inc., Santa Monica, Calif. Missile and Space Systems Div.

REPORT ON THE DEVELOPMENT OF THE MANNED ORBITAL RESEARCH LABORATORY (MORL) SYSTEM UTILIZATION POTENTIAL. TASK AREA IV: MORL SYSTEM IMPROVEMENT STUDY, BOOK 3

O. Taylor (Bendix Corp.) and D. C. Wensley Dec. 1965 329 p refs

(Contract NAS1-3612)

(NASA-CR-66290; SM-48817) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Presented are the results of analyses performed on the stabilization and control subsystem for the MORL system improvement study. Requirements imposed on the control stabilization system are reviewed, and detailed analyses and design data on tradeoff and definition studies performed in the improvement study are presented in appendices. Investigated were: (1) impulse sizing requirements caused by the external environment (namely, the aerodynamic and gravity forces, and torques which act on the vehicle); (2) attitude maneuvering using momentum storage actuators; and (3) man's role in control of the vehicle. Hardware studies included a definition of the total hardware system and selected sensors, as well as the sensor inflight and calibration concept, and a tradeoff study with mechanization of the precision inertial reference requirements. G.G.

N67-19865*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

A COMPENDIUM OF NASA AEROBEE SOUNDING ROCKET LAUNCHINGS FOR 1964

Jon R. Busse, Merrill T. Leffler, George E. Kraft, and Paul S. Bushnell, Jr. Dec. 1965 109 p refs

(NASA-TM-X-55712; X-721-65-452) CFSTI: HC $3.00/MF $0.65 CSCL 22D

A total of twenty-eight NASA Aerobee sounding rocket vehicles were launched during the calendar year 1964. The data presented in this report provides a view of overall Aerobee performance for 1964 which can be useful in evaluating past Aerobee performance capabilities. Additionally, this information is useful to all scientists who are interested in obtaining data on Aerobee sounding rocket vehicle performance. In the chronology section of this report, each of the twenty-eight flights in 1964 is analyzed, including reduced flight performance data where significant to the discussion. Two cross reference indices and another summarizing chart are provided in the appendix which can be useful in comparing overall statistics with each flight, or for cross referencing particular similarities between flights. Also included in the appendix are useful performance characteristic charts and representative flight performance curves. Author

N67-19874* Douglas Aircraft Co., Inc., Santa Monica, Calif. Missile and Space Systems Div.

REPORT ON THE DEVELOPMENT OF THE MANNED ORBITAL RESEARCH LABORATORY (MORL) SYSTEM UTILIZATION POTENTIAL. TASK AREA V: PROGRAM PLANNING AND ECONOMIC ANALYSIS

C. G. Armstrong Jan. 1966 370 p

(Contract NAS1-3612)

(NASA-CR-66294; SM-48820) CFSTI: $3.00 CSCL 22B

Presented is a summary of the program implementation planning and economic analysis for the MORL system. Considered are the total cost of the MORL Program, the anticipated critical problem areas, the overall implementation phasing, and the major guidelines and constraints affecting program implementation. The objectives of the four phased planning areas are: (1) technical and economical feasibility of a number of system concepts; (2) preliminary project definition of the total system concept selected; (3) final definition of the technical concept and program plans of the selected concept; and (4) conduct of hardware development and operations for the system concept. The derived implementation schedule is presented in graphical form and covers the years to 1974. The mission plan emphasizes the growth in orbital activity with implied, expanded facilities and techniques based on capabilities developed in the Gemini and lunar programs. G.G.

N67-19893* National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.

STABILITY CHARACTERISTICS OF THE APOLLO COMMAND MODULE

William C. Moseley, Jr., Robert H. Moore, Jr., and Jack E. Hughes (ITT/Federal Elec. Corp.) Washington, NASA, Mar. 1967 110 p refs

(NASA-TN-D-3890) CFSTI: $3.00 CSCL 22B

Investigations have been made to determine the static and the dynamic stability characteristics of the Apollo command module over a Mach number range of 0.2 to 18.73. They included tests of the clean command module and the refined vehicle with surface protuberances and cavities. The tests covered angles of attack between 0° and 360°. The hypersonic lift–drag ratio needed to control the flight path of the Apollo command module is obtained through a design which places the center of gravity in an offset location, thus providing a trimmed entry angle of attack with the main heat shield forward. It was shown that the lift–drag ratio necessary for entry can be obtained by proper placement of the center of gravity while still maintaining stability. Static stability data indicate an undesirable trim point (apex forward) at angles of attack between 10° and 50°, which was especially prominent at subsonic speeds. A severe scattering of data resulted from a flow separation associated with this angle-of-attack range. Dynamic stability derivatives were obtained using forced-oscillation, limited free-oscillation, and free-to-tumble test techniques. The test results indicated that the command module generally has positive damping in the entry flight attitude, except at the low subsonic Mach numbers equal to or less than 0.7. Author

N67-19909*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.

A COMPARISON OF SOME PREDICTED AND MEASURED VARIABLES FOR A FULL-SCALE SURVEYOR DROP TEST

J. A. Garba 1 Mar. 1967 32 p refs

(Contract NAS7-100)

(NASA-CR-82994; JPL-TR-32-1084) CFSTI: HC $3.00/MF $0.65 CSCL 22B

The correlation is described between the predicted and measured dynamic behavior for a full-size Surveyor drop test. The investigation includes a detailed examination of the test uncertainties encountered in a full-scale stability drop of a three-legged vehicle and the effect of such uncertainties on the correlation between experimental and theoretical results. Time histories of the pertinent variables are presented and discussed. Author

N67-19984* Douglas Aircraft Co., Inc., Santa Monica, Calif. Missile and Space Systems Div.

REPORT ON THE DEVELOPMENT OF THE MANNED ORBITAL RESEARCH LABORATORY SYSTEM UTILIZATION POTENTIAL. TASK AREA I: ANALYSIS OF SPACE RELATED OBJECTIVES, BOOK 1

H. L. Wolbers Sep. 1965 238 p refs

(Contract NAS1-3612)

(NASA-CR-66282; SM-48807) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Space related objectives are presented for the Manned Orbital Research Laboratory. Data include an updated baseline experiment list with appropriate parametric information such as weight, power, and volume; a composite equipment list; a tabulation of crew requirements including skill levels and man-hours; description of the research potential in selected areas of Earth-centered observations; and suggestions for the criteria used in assigning research priorities to the orbital laboratory applications. The new Earth-oriented areas examined include cartographic/photogrammetric measurements, geophysical/geological measurements, meteorological research, certain Earth-centered measurements applicable to national defense, and oceanographic studies. Analysis of the collated list of 157 measurement areas indicated that weight, power, and volume requirements increased over the previous reported values. Of the experiments in an expanded list 40% require a mission duration of more than 90 days. Crew composition requirements in terms of skills were found to be the limiting constraint on scheduling experiments. S.P.

N67-19986*# Hughes Aircraft Co., El Segundo, Calif. Space Systems Div.

IONOSPHERIC ELECTRON CONTENT-SYNCHRONOUS ORBIT BEACON EXPERIMENT DEFINITION Interim Final Report

Dec. 1966 140 p refs

(Contract NAS8-18116)

(NASA-CR-82975, B-1204; SSD-60543R) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Presented is the final technical report and the management and resources plan for the experiment (Ionospheric Beacon Satellite). The design is based on the Early Bird synchronous communication satellite and is to be launched on an Apollo Applications Program flight. Covered are: (1) orbit considerations; (2) satellite payload; (3) telemetry and command, control, and electrical power subsystems; (4) structure and general arrangement; (5) satellite reliability; (6) Apollo interface and astronaut function; (7) thermal considerations; (8) spacecraft systems testing; and (9) ground telemetry and command station. K.W.

N67-20012*# Astro-Space Labs., Inc., Huntsville, Ala.

FREON INJECTION TECHNIQUES FOR SATURN SYSTEMS LEAK CHECK Final Report

20 Feb. 1967 6 p

(Contract NAS8-11910)

(NASA-CR-82996; FR67-4) CFSTI: HC $3.00/MF $0.65 CSCL 22D

A device for pressurizing tanks with a mixture of Freon 22 and air for leak detection purposes is described. The Freon injection system is designed to fill tanks with a mixture containing 1% Freon 22. This will allow leaks of 10^{-5}cc/min to be reliably detected with commercial halocarbon leak detectors. The system is designed to pressurize tanks of up to 50,000 cubic feet, and to operate at pressures up to 2400 psig. The system fills the tank to be tested with an automatically regulated constant percentage mixture of Freon 22 and air. Since the Freon 22 and air are mixed as the tank is filled, a uniform mixture is achieved throughout the tank volume. These characteristics make it possible to make consistent and repeatable leak detection tests. Author

N67-20161*# Douglas Aircraft Co., Inc., Santa Monica, Calif. Missile and Space Systems Div.

REPORT ON THE DEVELOPMENT OF THE MANNED ORBITAL RESEARCH LABORATORY (MORL) SYSTEM UTILIZATION POTENTIAL. TASK AREA II: INTEGRATED MISSION DEVELOPMENT PLAN, BOOK 3

N. Kallay Oct. 1965 275 p refs

(Contract NAS1-3612)

(NASA-CR-66285; SM-48812) CFSTI: HC $3.00/MF $0.65 CSCL 22A

Application plan descriptions are given for tasks to be accomplished on board a manned orbital research laboratory. Included in the descriptions are a brief justification for the task, lists of time dependent resources required to perform the task, and data pertinent to a computerized experiment scheduling program. C.T.C.

N67-20162*# Douglas Aircraft Co., Inc., Santa Monica, Calif. Missile and Space Systems Div.

REPORT ON THE DEVELOPMENT OF THE MANNED ORBITAL RESEARCH LABORATORY (MORL) SYSTEM UTILIZATION POTENTIAL. TASK AREA II: INTEGRATED MISSION DEVELOPMENT PLAN, BOOK 2

N. Kallay Oct. 1965 204 p For abstract see N67-20161 09-31

(Contract NAS1-3612)

(NASA-CR-66284; SM-48811) CFSTI: HC $3.00/MF $0.65 CSCL 22A

N67-20163*# Douglas Aircraft Co., Inc., Santa Monica, Calif. Missile and Space Systems Div.

DEVELOPMENT OF THE MANNED ORBITAL RESEARCH LABORATORY (MORL) SYSTEM UTILIZATION POTENTIAL. TASK AREA IV: MORL SYSTEM IMPROVEMENT STUDY, BOOK 1

J. L. Allen Dec. 1965 325 p refs

(Contract NAS1-3612)

(NASA-CR-66288; SM-48815) CFSTI: HC $3.00/MF $0.65 CSCL 22A

Baseline changes in the configuration and interior design are described, and results of improvement studies for structures, electrical power, logistics, and vehicle performance are presented. Mission analysis changes are also discussed, problem areas chargeable to the alternate missions are outlined, and alternate concepts and studies for future MORL research are identified. The solar cell/battery and the Pu-238 isotope Brayton cycle (PBC) system are compared. The recommendation is made that a PBC system of 11 kW nominal capacity be used as the baseline power system for the MORL. Payload requirements and laboratory weight are assessed, and the resulting discretionary payload is derived. Analytical data are also included on axial handling and stowage system; solar cell panel shadowing; electrical loads; and isotope costs. Flow charts present the technological requirements of a solar cell/battery system that could be implemented in support of the MORL development. M.G.J.

N67-20166*# Douglas Aircraft Co., Inc., Santa Monica, Calif. Missile and Space Systems Div.

REPORT ON THE DEVELOPMENT OF THE MANNED ORBITAL RESEARCH LABORATORY (MORL) SYSTEM UTILIZATION POTENTIAL. TASK AREA IV: MORL SYSTEM IMPROVEMENT STUDY, BOOK 5, VOLUME 1

A. Pisciotta Jan. 1966 307 p refs

(Contract NAS1-3612)

(NASA-CR-66292; SM-48819A) CFSTI: HC $3.00/MF $0.65 CSCL 22A

The MORL Propulsion/Reaction Control System (P/RCS) study consisted of (1) an advance P/RCS study, (2) a baseline system evaluation study, and (3) a systems integration study. The advance P/RCS study consisted of an evaluation of advanced chemical, electrical, and radioisotope thermal propulsion system concepts for application to the MORL mission. A Resistojet and a radioisotope thrustor system were selected for preliminary design integration into the MORL system. The baseline system evaluation study consisted of a review of the components of the P/RCS baseline system to establish those components of the system requiring updating of the design as a result of advances in technology, related subsystem design changes resulting from the MORL responsiveness analysis, and the change in the anticipated MORL launch date to the 1970 time period. The systems integration study utilized the results of the two previous studies to integrate the preliminary designs of both the updated liquid bipropellant system and the two advanced systems with the MORL mission and operations. Author

N67-20170* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
SMALL STANDARD SATELLITE (S^3) FEASIBILITY STUDY
G. W. Longanecker, D. J. Williams, and R. O. Wales Mar. 1966 157 p
(NASA-TM-X-55698; X-724-66-120) CFSTI: $3.00 CSCL 22B

A study was conducted to determine the desirability and feasibility of a small standard satellite system designed to accommodate a variety of missions within the magnetosphere. The standardization is achieved by (1) selecting a basic satellite structure to be used for all missions, and (2) employing a modular concept for the spacecraft interfaces and final assembly. It was found that a family of small standard satellites weighing from 70 to 130 pounds can be designed to accommodate a large majority of the missions. Considerable savings in money and manpower can be realized with the obtained concept, with critical spacecraft subsystems utilized from mission to mission without the requirement for redesign. C.T.C.

N67-20248*# National Aeronautics and Space Administration, Washington, D. C.
MANNED SPACE FLIGHT: APOLLO
[1966] 16 p
(NASA Facts 23, Vol. IV, No. 7; NASA Facts, Vol. III, No. 1) GPO: $0.15 CSCL 22B

Components of the Apollo spacecraft, which will carry astronauts safely to and from another body in the solar system, are described. The method of lunar orbit rendezvous was chosen because it significantly reduces the rocket power required for landing on and taking off from the moon. The command module, launch escape system, service module, adapter, and lunar module are briefly described and illustrated. Attention is also given to guidance and navigation, the astronauts, wardrobe, and Apollo's three launch vehicles. The history of the three unmanned spacecraft programs is reviewed, and aspects of training and moon flight tracking are considered. The complete flight, from lift off to spacecraft recovery, is illustrated. S.P.

N67-20281*# National Aeronautics and Space Administration, Washington, D. C.
PROJECT ATS-A
31 Mar. 1967 41 p
(NASA News Release-67-71) Available from the Scientific and Technical Information Division CSCL 22B

Discussed is the second Applications Technology Satellite to be launched after April 4, 1967, by an Atlas-Agena vehicle into a 6,900-mile orbit. The primary mission objective of this space vehicle is to test and evaluate a passive gravity gradient control system which uses the force of gravity to keep the spacecraft stabilized on three axes and pointed toward the Earth. In addition to the gravity gradient experiment, ATS-A will carry communications, meteorological, and several scientific experiments to measure the orbital environment of the satellite. ATS-A will carry two standard television cameras as a part of the gravity experiment that will provide measurements of the bending effects due to solar heating and radiative cooling on the booms extending out from the satellite. The amount of boom bending will be compared with later synchronous flights. Other tests slated for ATS-A include a microwave communications experiment, two meteorological cameras, an environmental measurements experiment and a Department of Defense albedo experiment. Author

N67-20294# European Space Research Organization, Paris (France).
SPACECRAFT TECHNOLOGY. VOLUME VII: THE ORBITING ASTRONOMICAL OBSERVATORY
Nancy G. Roman (NASA, Washington, D. C.) Oct. 1966 31 p Presented at the 2d ESRO Summer School, Oxford, 1964
(ESRO-SP-15) CFSTI: HC $3.00/MF $0.65

The present lecture deals primarily with the areas of satellite design in which difficulties arose in the development of the orbiting astronomical observatory. A brief account is given of the history of the project, followed by a description of the OAO and its command and data handling system. The scientific experiments selected for the first three OAO spacecraft are described. Author (ESRO)

N67-20297# European Space Research Organization, Paris (France).
ATTITUDE CONTROL OF STELLAR OBSERVATORY SATELLITES
W. G. Hughes (RAE) Apr. 1966 23 p refs Presented at the ESRO Summer School, Oxford, 26 Aug. 1964
(ESRO-TM-39) CFSTI: HC $3.00/MF $0.65

Considered are satellites whose purpose is to obtain high-resolution stellar ultra-violet spectra. The design of overall control systems for such satellites is illustrated by reference to a British design study and to the American orbiting observatory. Author (ESRO)

32 STRUCTURAL MECHANICS

Includes structural element design and weight analysis; fatigue; thermal stress; impact phenomena; vibration; flutter; inflatable structures; and structural tests. For related information see also: 17 Materials, Metallic; and 18 Materials, Nonmetallic.

N67-19414# Toronto Univ. (Ontario).
INDUSTRIAL AND ARCHITECTURAL AERODYNAMICS
In its Ann. Progr. Rept., 1966 Oct. 1966 p 83-84 (See N67-19403 09-34)

Aerodynamic tests of the proposed Air Canada Pavilion at Expo 67 were made in a subsonic wind tunnel. Because of the unconventional design of the building, two models were tested. The first was a rigid model instrumented with pressure taps. The second was a dynamically similar aeroelastic model. The internal construction of the aeroelastic model is illustrated. In addition, tests of Short and Mason anemometers and ancillary equipment for the water dousing system of a nuclear generating station were made. S.P.

N67-19459# ARO Inc., Arnold Air Force Station, Tenn.
TEMPERATURE RESPONSE OF AN INFINITE FLAT PLATE WITH UNSYMMETRICAL BOUNDARY CONDITIONS
L. J. Ybarrondo and F. H. Smith, Jr. Arnold Eng. Develop. Center, Jan. 1967 25 p refs
(Contract AF 40(600)-1200)
(AEDC-TR-66-166; AD-6446424) CFSTI: HC$3.00/MF$0.65

Exact solutions for the transient temperature distribution and the stored energy in an infinite plate of finite thickness are presented for the case of different convective environments at each face of the plate. The solution is general and contains numerous limiting cases, including that of steady state. Eigenvalues are given for many combinations of the system Biot numbers for the initial response period. An example is presented to illustrate the application of the solution to the practical problem of a rocket engine diffuser.
Author (TAB)

N67-19483 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
STATE OF STRESS OF CYLINDRICAL SHELLS WITH ELASTIC FRAMES
E. V. Antonenko *In its* Aviation Eng., Vol. 7, No. 3 28 Sep. 1966 p 9–17 refs (See N67-19481 09-34) CFSTI: HC$3.00

Strengths of cylindrical shells with elastic edge frames in their planes and varied conditions of support are considered for shells with constant loading and with cross sections symmetrical to any diametrical plane. All of the moments and forces are determined, and the integration constants are found from the boundary conditions. An example shows how the constants of integration are obtained for a hinge-supported shell; and a filled pipeline of specified dimensions is used to illustrate the influence of the elasticity of frames on the state of stress of a shell. To obtain the latter, it is assumed that the supports of the frames insure both (1) reactions in the form of flows of tangent forces that change according to the law sin ϕ and (2) radial direction of reactions along the lower half of the frames that changes according to the law of hydrostatic pressure.
M.W.R.

N67-19484 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
EQUATIONS OF SANDWICH PLATES OF VARIABLE THICKNESS
V. V. Yershov *In its* Aviation Eng., Vol. 7, No. 3 28 Sep. 1966 p 19–28 refs (See N67-19481 09-34) CFSTI: HC$3.00

Variational methods are used to derive equations that consider the compressibility of filler of sandwich plates of variable thickness. The obtained equations can be used to calculate the strengths of ailerons, trim tabs, control of aircraft with fillers, and helicopter rotors. It is assumed that the deflection component of the filler changes linearly with its thickness, and that the external layers of plates made from durable orthotropic material have constant thicknesses and are incompressible. The necessary equations are evolved, and the Hooke law for an orthotropic body is used to express the stresses through deformations. Filler stresses and pressure between layers of filler are designated, as are the rigidities of extension and shift, bending and twisting moments and their rigidities, and the deformation of filler and external layers on virtual displacement. The integration procedure is detailed, and simplification of the equations considered.
M.W.R.

N67-19485 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
INVESTIGATION OF STABILITY OF SHELLS OF CYLINDRICAL CLASS ON THE BASIS OF COMPLEX EQUATIONS
A. V. Sachenov *In its* Aviation Eng., Vol. 7, No. 3 28 Sep. 1966 p 29–38 refs (See N67-19481 09-34) CFSTI: HC$3.00

Equations that consider initial momentless stresses are used to determine the stability of closed shells of rotation subjected to both torsion and external pressure. Stability and vibrations of a rotating cylindrical shell with a very hollow meridonal arc of circumference is discussed; and attention is given to the case of a shell (1) that is freely supported on both edges and (2) with one edge freely supported and the other free with respect to deflection.
M.W.R.

N67-19490 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
THE PROBLEM OF NATURAL VIBRATIONS OF BLADES OF AN AXIAL COMPRESSOR
I. M. Movshovich *In its* Aviation Eng., Vol. 7, No. 3 28 Sep. 1966 p 73–80 ref (See N67-19481 09-34) CFSTI: HC$3.00

In order to study the self-exciting vibrations in high performance and large load-carrying axial compressors, a profile of purely bending vibrations is considered that possesses reduced blade mass and the aerodynamic properties of its peripheral section. An amplitude-frequency equation of the forced vibrations of a self-exciting system is presented, and curves are graphed to show the amplitudes of and the phase shifts between the vibrating blades. An approximate expression of blade displacement, dependent upon time, is used to define the aerodynamic forces; and the other forces applied to the blade are obtained. Scattering of vibration stresses in blades and phase shifts between blades of one collar are thus explained.
M.W.R.

N67-19491 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
VIBRATIONS OF A CYLINDRICAL SHELL PARTIALLY FILLED BY FLUID
V. F. Natushkin and I. S. Rakhimov *In its* Aviation Eng., Vol. 7, No. 3 28 Sep. 1966 p 81–85 refs (See N67-19481 09-34) CFSTI: HC$3.00

The influence of a fluid on the frequencies of free vibrations of circular cylindrical shells under arbitrary boundary conditions is discussed. A vertically standing shell is considered, and a solution is given for the dynamic condition of disturbed motion of the fluid on the shell surface. Frequencies of natural vibrations for smooth and reinforced cylindrical shells are determined by the motion equations; and a solution is found for the frequency dependency of a shell partially filled with fluid.
M.W.R.

N67-19492 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
VIBRATIONS OF A HEMISPHERIC SHELL FILLED BY A FLUID
Ye. A. Samoylov and B. S. Pavlov *In its* Aviation Eng., Vol. 7, No. 3 28 Sep. 1966 p 87–94 refs (See N67-19481 09-34) CFSTI: HC$3.00

Differential equations based on membrane theory are used to determine the axisymmetric vibrations of a hemispherically-shaped elastic thin shell filled with fluid. Hydrodynamic pressures are found with the aid of a Lagrange–Cauchy expression, and the potential of speeds is determined for an ideal fluid whose free surface remains flat by a Laplace equation in polar coordinates. Equations are given to obtain approximate values of the natural frequencies and forms of vibrations of a shell filled with fluid, and an experiment with a tank filled with water is described. Good agreement is found between the experimental results and theoretical calculations.
M.W.R.

N67-19550# Vitro Labs., Silver Spring, Md.
NONSEPARABLE SOLUTIONS OF THE HELMHOLTZ WAVE EQUATION EXAMINED FOR APPLICATIONS Final Report, 28 Jun. 1965–28 Apr. 1966

Donald S. Moseley and James M. Render Jul. 1966 61 p refs
(Contract DA-44-177-AMC-342(T))
(TR-01944.01-1; USAAVLABS-TR-66-59; AD-640174) CFSTI: HC$3.00/MF$0.65

A conventional solution of the Helmholtz or time-reduced wave equation is a simple product of functions that contain one coordinate variable in each. An unbounded set of solutions that are not separable into simple products of single-variable functions has been partially examined for applicability to vibrational problems. Applications to scalar usage have been found, and illustrations including shapes and frequencies for membranes and an acoustic cavity are reported. Efforts to make application to vector usage are described, as are numerous mathematical properties that have been discovered in the course of the work. It is concluded that vibration on or within some new shapes can now be calculated exactly with functions formed of the nonseparable solutions added to separable solutions. It is also concluded that simplifications in the mathematics and additional applications await the effort.
Author (TAB)

N67-19578# California Univ., La Jolla. Dept. of the Aerospace and Mechanical Engineering Sciences.
OPTIMUM PLASTIC DESIGN OF A PORTAL FRAME FOR ALTERNATIVE LOADS
William Prager Oct. 1966 14 p refs
(Contract N00014-67-A-0109-0003)
(TR-2; AD-640859) CFSTI: HC$3.00/MF$0.65

Minimum-weight design of a portal frame for alternative combinations of horizontal and vertical loads is discussed. It is shown that the usual proof of the existence of a Foulkes mechanism as a necessary condition for minimum weight cannot be carried over to this problem.
Author (TAB)

N67-19735# Drexel Inst. of Tech., Philadelphia, Pa.
PROPAGATION OF CYLINDRICAL SHEAR WAVES IN NONHOMOGENEOUS ELASTIC MEDIA Final Report
Pei Chi Chou and Richard J. Schaller Nov. 1966 23 p refs
(Contract DA-18-001-AMC-876(X))
(Rept.-125-10; AD-642499) CFSTI: HC$3.00/MF$0.65

The method of characteristics is applied to the set of equations which governs the propagation of axially symmetric torsional shear waves in nonhomogeneous elastic media. The wave velocities, characteristic equations, and the equations governing the propagation of abrupt changes (discontinuous wave fronts) are derived in closed form. Numerical integration along the characteristic directions was carried out for several examples on an electronic computer. The solutions of three specific examples calculated show general agreement with existing solutions by other methods. For certain problems, the method of characteristics yield additional results which cannot be obtained by the Laplace transform method.
Author (TAB)

N67-19768# J. G. Engineering Research Associates, Baltimore, Md.
FAR FIELD SOUND RADIATION FROM RANDOMLY VIBRATING STRUCTURES
Joshua E. Greenspon Jun. 1966 31 p refs
(Contract Nonr-5040(00))
(TR-15; AD-642413) CFSTI: HC$3.00/MF$0.65

The report presents general relationships for the cross spectral density of the sound pressure radiated from a randomly vibrating structure oscillating in an acoustic medium. Simplified relationships for the mean square far field pressure are given for the case of low damping. A free field Greens Function is introduced to study the directivity of the radiation from cylindrical structures.
Author (TAB)

N67-19799# IIT Research Inst., Chicago, Ill. Dept. of Mechanics.
YIELD-POINT LOAD OF A CIRCULAR PLATE SEALING BY INCOMPRESSIBLE FLUID
Philip G. Hodge, Jr., and Chang-kuei Sun Oct. 1966 24 p refs
(Contract Nonr-1406(04))
(DOMIIT-1-32; AD-644628) CFSTI: HC$3.00/MF$0.65

The yield point load is obtained for a simply supported circular plate which seals a cavity filled with an incompressible liquid and is loaded over a central region. The interaction between a load over a central region acting in one direction and an independent uniform pressure acting in the opposite direction on the plate is also studied. The results obtained are compared with solutions from elastic analysis.
Author (TAB)

N67-19818# David Taylor Model Basin, Washington, D. C. Structural Mechanics Lab.
STATIC AND CYCLIC FATIGUE TESTS OF FUSION-SEALED PYREX SPHERES
Kanehiro Nishida Sep. 1966 27 p refs
(DTMB-2246; AD-642404) CFSTI: HC$3.00/MF$0.65

The feasibility of developing reliable glass floats for the search vehicle of the Deep Submergence Systems Project was explored by a proof-testing approach. The investigation incorporated static and cyclic fatigue tests of 10-in.-diameter, fusion-sealed, annealed Pyrex glass spheres under hydrostatic pressure. The results of three series of models tested at different loading rates in sea water showed no apparent effect of loading rate on collapse strength. A fourth series of models tested in oil showed no appreciable difference in strength when compared to the models tested in sea water. Four models initially proof tested to a depth of 30,000 ft survived 5000 cycles of pressure to a depth of 22,500 ft. Each model was then tested to destruction at depths in excess of 30,000 ft. The results obtained in these tests were exploratory and should be used with caution. However, with the possible exception of one model which may have suffered cyclic damage, the results are sufficiently encouraging to warrant further investigations.
Author (TAB)

N67-19825# Toronto Univ. (Ontario). Inst. for Aerospace Studies.
MULTIPOINT INITIATED IMPLOSIONS FROM HEMISPHERICAL SHELLS OF SHEET EXPLOSIVE
J. E. Kennedy (IIT Res. Inst.) and I. I. Glass Dec. 1966 31 p refs
(Contract AF 33(657)-7874)
(UTIAS-TN-99; AD-643669) CFSTI: HC$3.00/MF$0.65

Some preliminary results are given on the generation of implosion waves by simultaneously detonating a hemispherical shell of sheet explosive at 91 individual initiation sites. The 7 in. dia. x 0.168 in. thick shell was formed from eight orange-peel segments cemented on a steel backing shell 0.1 in. thick, which was perforated to take the 91 detonators. A scalloped type shock wave surface was generated from the 91 individual detonation sites that imploded into the gas space. The distortions of the shock wave surface increased as the implosion wave gained in strength while converging on the origin. It would seem from the limited experiments that this may not be a useful way of producing implosions. However, it appears to be a useful method of investigating instabilities of implosion waves arising from controlled disturbances.
Author (TAB)

N67-19846# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
DIFFERENTIAL EQUATIONS OF A DISK OF ASYMMETRICAL PROFILE

Yu. M. Shevchenko 14 Jul. 1966 11 p ref Transl. into ENGLISH from Dopovidi Akad. Nauk Ukr. RSR (Kiev), no. 2, 1965 p 180–184
(FTD-TT-65-1949; AD-643923) CFSTI: HC $3.00/MF $0.65

An examination was made of the strained state of a disk of an asymmetrical profile as a round plate of variable thickness, which is situated in an axially symmetrical space temperature field under the effect of surface axially symmetrical load and centrifugal forces. Author (TAB)

N67-19856*# Jet Propulsion Lab., Calif. Inst. of Tech.
THE DYNAMIC ENVIRONMENT OF SPACECRAFT SURFACE TRANSPORTATION
J. W. Schlue 15 Mar. 1966 25 p
(Contract NAS7-100)
(NASA-CR-71771; JPL-TR-32-876) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Data on the shock and vibration environment imposed on a spacecraft during surface transportation are discussed. Acceleration amplitude statistics and predominate frequencies of different locations within a typical air ride suspension van are presented. Instrumentation requirements associated with this acquisition of transportation data are also included. Author

N67-19872* Boeing Co., Seattle, Wash. Aerospace Group.
A STUDY OF WELDMENTS AND PRESSURE VESSELS MADE OF HY-150 STEEL PLATES Final Report, 8 Nov. 1965–9 Dec. 1966
C. F. Tiffany, J. N. Masters, and R. E. Regan Jan. 1967 178 p refs
(Contract NAS3-2755)
(NASA-CR-72155; D2-113433-1) CFSTI: $3.00 CSCL 20K

Automated weld procedures, weld wire compositions, gas compositions, and post weld heat treatments were evaluated on 1.0 inch thick plates of a 5Ni-Cr-Mo-V air melt steel. Tensile, conventional charpy, precracked charpy, single edge notch, and surface flawed fracture specimens were tested to determine parameters which would produce welds of highest quality and toughness. From results of these and of five vessel cyclic and burst tests, it was demonstrated that this alloy, assembled with gas tungsten arc procedures, is capable of meeting a "leak-before-failure" design criteria for 260-inch diameter motor cases. Author

N67-19885*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
A NUMERICAL METHOD FOR DETERMINING HEATING RATES FROM THICK-CALORIMETER DATA
C. W. Stroud Washington, NASA, Mar. 1967 23 p refs
(NASA-TN-D-3846) CFSTI: HC $3.00/MF $0.65 CSCL 20M

A method is presented for reducing the data from a thick calorimeter to determine the heating rate to the surface of the calorimeter. The technique employed was to obtain a numerical solution to the inverse problem of heat transfer by using a digital computer. The variation of material properties with temperature is considered. Calculations are compared with experimental results obtained in an arc-heated air jet. Author

N67-19933* Astro-Space Labs., Inc., Huntsville, Ala.
FEASIBILITY STUDY AND DEVELOPMENT OF A RELIABLE AND ACCURATE COMMON BULKHEAD CORRECTIVE MEASUREMENT Final Report
[1966] 86 p refs
(Contract NAS8-20250)
(NASA-CR-82930; ASL-67-1) CFSTI: HC $3.00 CSCL 20K

A method is demonstrated for obtaining the necessary measurements to contour both surfaces of a bulkhead honeycomb structure using three-dimensional numerically-controlled milling machinery. These measurements are then fed into a computer, which performs the operation of a curve fitting and generates the numerically controlled machining commands. A number of test shells were measured and it is reported that the sum of all errors did not exceed 0.015 inch. The major portion of this error was in the ultrasonic reading of the void distance. It is felt that by addition of highly automated data gathering equipment, this system can be applied to the fabrication of large and complex structures. A.G.O.

N67-19941* General Electric Co., Cincinnati, Ohio.
BASIC RESEARCH ON LIQUID-DROP-IMPACT EROSION Quarterly Report, 8 Sep.–8 Dec. 1966
Olive G. Engel 8 Dec. 1966 32 p refs
(Contract NASw-1481)
(NASA-CR-82957; QPR-1) CFSTI: $3.00 CSCL 20K

Initially discussed are results of a previous study concerning drop impact stresses, equations for crater depth, and erosion failures of brittle and ductile solids. Considerations for the experiments that were subsequently conducted include procurement and fabrication of test plates of the specified metals, procurement of steel spheres, sound speed determination, metal yield strengths, and the single impact device. The theoretical aspects that are covered include the denting velocity equation, denting velocity as a means of predicting relative erosion resistance, and use of the denting velocity to determine the dynamic compressive yield strengths of metals. K.W.

N67-19954* Oklahoma State Univ., Stillwater.
NO TITLE Progress Report, 1 Jun.–30 Nov. 1966
J. A. Wiebelt Dec. 1966 86 p refs
(Grant NsG-454)
(NASA-CR-82945) CFSTI: $3.00 CSCL 22B

Two thermal control systems for use on spacecraft are analyzed and compared. Both are passive-active systems consisting of a surface which has fins made of thermostatic material. The fins will react to their local temperature causing a variation in the ratio of the solar absorptance to the terrestrial emittance. In the first system the fins are considered to be specular material with low emittance and absorptance surfaces, while the base is assumed to be a diffuse material with low absorptance and high emittance or a white paint. To improve this system, a second system was analyzed in which the fins are coated with a low absorptance and high emittance material. It is concluded that both systems have characteristics which make either of them useful in spacecraft thermal control. The specular base diffuse fin system appears to be slightly more useful in the case of solar irradiation. Also discussed is the spectral calibration of the high pressure zenon arc lamp that was used in solar simulation. K.W.

N67-20021*# Israel Program for Scientific Translations, Ltd., Jerusalem.
THEORY OF SHELLS AND PLATES
S. M. Dugar'yan, ed. 1966 1081 p refs Transl. into ENGLISH of Book "Teoriya Obolochek i Plastin" Erevan, Izd. AN Arm. SSR, 1964 Proc. of the 4th All-Union Conf. on Shells and Plates, Erevan, 24–31 Oct. 1962 Published for NASA and NSF
(NASA-TT-F-341; TT-66-51021) CFSTI: HC $3.00/MF $0.65 CSCL 20K

Conference papers on general problems of theory, stability and nonlinear problems, dynamics, thermo-elasticity, creep, plasticity, and structural mechanics of shells and plates are presented. For individual titles see N67-20022–N67-20143.

N67-20022*# Israel Program for Scientific Translations, Ltd., Jerusalem.

APPLICATION OF METHODS OF THE THEORY OF PROBABILITY IN THE THEORY OF PLATES AND SHELLS

V. V. Bolotin *In its* Theory of Shells and Plates 1966 p 1–45 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

A comprehensive survey is presented on probability methods used in the theory of plates and shells, and the relative advantages and disadvantages of each are assessed, along with its particular fields of application. Three groups of methods are examined. (1) The quasi-steady methods are used primarily for interpretation and analysis of stability tests of shells. They are considered the principal means for solving those problems in which the input parameters are random quantities and/or deterministic functions of time which depend on a finite number of random quantities. (2) Correlation methods are applied to problems of small oscillations of plates and shells under the action of loads representing a steady-state random process. They are considered effective in solving linear problems, particularly in the case of normal distribution processes. (3) Kinetic equations are employed to describe the behavior of shells at such large random impacts that popping is possible; their application to problems concerning the theory of Brownian motion is stressed. A bibliography on studies in this field is included. M.G.J.

N67-20023*# Israel Program for Scientific Translations, Ltd., Jerusalem.

CERTAIN PROBLEMS OF THE USE OF STATISTICAL METHODS IN THE THEORY OF STABILITY OF PLATES AND SHELLS

I. I. Vorovich *In its* Theory of Shells and Plates 1966 p 46–75 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

The requirements necessary to develop the statistical theory of the stability of elastic systems are defined, and the available data on main features which should be included in the theory are analyzed. The factors which determine the random character of shell deformation are categorized as scatter of the mechanical and geometric parameters of the shell, of the support conditions, and of the external loads. The possibilities of establishing relationships between the statistical characteristics of these groups and those of shell deformations are considered. In addition to problems of shell stability due to statistical loading, the use of statistical methods in dynamic problems is surveyed, and several examples are included. General problems of interest related to the theory of the stability of elastic systems are formuated. An extensive bibliography is included. M.G.J.

N67-20024*# Israel Program for Scientific Translations, Ltd., Jerusalem.

INTEGRAL-DIFFERENTIAL AND INTEGRAL EQUATIONS OF STATICS AND DYNAMICS OF THIN ELASTIC SHELLS

N. A. Kil'chevskii *In its* Theory of Shells and Plates 1966 p 76–87 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Studies in the field of the applied theory of elasticity were surveyed and classified according to the starting premises used in establishing the integral and integral–differential equations of the theory of shells. These include: (1) equations derived from the reciprocity theorem of the three-dimensional theory of elasticity; (2) equations of the theory of shells with clearly defined displacements of a plate whose middle plane is a map of the middle surface of a shell; and (3) direct transformation of differential equations of boundary value problems in the classical theory of shells to systems of integral–differential and integral equations. Each method is briefly described. The significance of the method of integral equations is assessed, and it is concluded that use of the method is effective in obtaining approximate solutions to boundary value problems. A bibliography is included. M.G.J.

N67-20025*# Israel Program for Scientific Translations, Ltd., Jerusalem.

DEVELOPMENT OF THE METHOD OF COMPLEX TRANSFORMATION IN THE LINEAR THEORY OF SHELLS DURING THE LAST FIFTY YEARS

V. V. Novozhilov *In its* Theory of Shells and Plates 1966 p 88–95 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

The role of the complex transformation as a means of eliminating negligible terms from the equations of the theory of shells is discussed, and its value in solving specific problems is considered. It is pointed out that when these equations are written in complex form, their order is reduced by a factor of two. Examples cited are problems involving axisymmetric shells, toroidal shells under symmetric and antisymmetric loads, general deformations of axisymmetric shells, cylindrical shells of arbitrary cross section, and circular cylindrical shells. Also considered are the types of boundary conditions which permit complex formulations. M.G.J.

N67-20026*# Israel Program for Scientific Translations, Ltd., Jerusalem.

NONLINEAR PROBLEMS OF STRESS CONCENTRATION NEAR HOLES IN PLATES

G. N. Savin *In its* Theory of Shells and Plates 1966 p 96–118 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

The necessity for more accurate formulation of problems pertaining to the theory of elasticity is stressed, and methods developed to treat nonlinear problems are surveyed. Attention is focused on the systems of equations established to solve (1) nonlinear plane problems related to stress concentration near round holes, and boundary value problems; (2) stress distribution in stress concentration zones; and (3) axisymmetric postcritical deformation of a thin annular plate, weakened by a small circular hole and subjected to uniform compression applied to its external contour. The several approaches taken, and the methods used in solving these problems are described. A list of references is included. M.G.J.

N67-20027*# Israel Program for Scientific Translations, Ltd., Jerusalem.

ANALYSIS OF BENDING AND VIBRATIONS OF PLATE SYSTEMS

N. P. Abovskii *In its* Theory of Shells and Plates 1966 p 119–125 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Bending of plate systems is analyzed by the methods of the theory of structures, which is basically a combination of the principle of superposition with numerical methods. By removing or imposing certain constraints the plate system is divided into a number of independent elements of the same type. Each typical plate element is analyzed by the relaxation method for the case of a contour subjected to unit forces or strain factors and to the given load. The solutions are represented in the form of tabulated plate deflections and are fundamental for the subsequent calculations. They are used to set up the equations of deformation continuity (also by numerical methods) at several points of connection. The method proposed reduces considerably the number of equations, as compared with the traditional relaxation method. Author

N67-20028*# Israel Program for Scientific Translations, Ltd., Jerusalem.

BENDING OF THICK PIPES

B. L. Abramyan *In its* Theory of Shells and Plates 1966 p 126–132 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

The stressed state of a thick pipe under the action of a bending load is considered. Equations are formulated to express the displacement components in cylindrical coordinates through four harmonic functions. It is assumed that a homogeneous elastic body of revolution is deformed symmetrically relative to plane xOz, and that the plane y=0 is the only plane of symmetry. The three-dimensional problem is then reduced to a two-dimensional problem. Boundary conditions are expressed for the problem of the bending of an infinite pipe by forces applied to its external lateral surface symmetrically relative to the xz plane. The displacements and stresses are determined from relationships expressed through the Fourier series and the Fourier integrals. Equations are also given for the case of a finite length of pipe subjected to the same bending load. M.G.J.

N67-20029*# Israel Program for Scientific Translations, Ltd., Jerusalem.

GENERAL EQUATIONS OF NONSYMMETRICAL SANDWICH SHELLS WITH A LIGHT FILLER

K. G. Abramyan *In its* Theory of Shells and Plates 1966 p 133–141 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Consideration is given to a thin nonsymmetrical sandwich shell of arbitrary shape loaded with a normal pressure. It is assumed that the filler is uncompressible but light, i.e., that it is subjected to transverse shear only. The normal element of the filler does not bend after the deformation and remains rectilinear. The Kirchhoff–Love hypothesis is considered to be true for the bearing layers. The problem is solved by the variational method. Author

N67-20030*# Israel Program for Scientific Translations, Ltd., Jerusalem.

ON THE BENDING OF A CANTILEVER PLATE WEAKENED BY A HOLE OF ARBITRARY SHAPE

A. M. Averin *In its* Theory of Shells and Plates 1966 p 142–145 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Equations are presented to solve the problem of concentration of stresses in a bent thin isotropic plate having a hole of arbitrary shape. Two cases are considered: a plate with an empty hole, and one with the hole filled by an absolutely rigid core. The extreme values of the bending moment on the contours of several holes are tabulated for both cases. M.G.J.

N67-20031*# Israel Program for Scientific Translations, Ltd., Jerusalem.

ON REFINED REISSNER-TYPE THEORIES OF PLATES

L. Ya. Ainola *In its* Theory of Shells and Plates 1966 p 146–152 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

An arbitrary function, representing the linear distribution of stresses through the plate thickness, is considered as an unknown function to be determined. The solution is based on the variational principle, and a system of integral–differential equations is derived, consisting of Reissner-type plate equations and an additional equation for determining the arbitrary function. Author

N67-20032*# Israel Program for Scientific Translations, Ltd., Jerusalem.

TWO PROBLEMS CONCERNING SANDWICH PANELS

A. Ya. Aleksandrov *In its* Theory of Shells and Plates 1966 p 153–166 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Equations are formulated for calculating the bending and buckling of sandwich panels with filler made of glass stampings or bars. Several filler configurations are examined and depicted, glass particle rigidity is considered, and the formulas used for determining the reduced moduli of normal elasticity of such fillers are given. The local stability of faces under longitudinal compression was studied for the case of bending corresponding to the deformation of the plate elements at shear. The critical loads were determined by the energy method. To select plate parameters corresponding to a minimum plate weight at a given load, the longitudinal compression of an infinitely wide sandwich plate with identical faces and a filler made of foamlex reinforced by ribs placed in the direction of compression was considered. The conditions to be fulfilled were general stability of the plate, local stability of the faces, and strength of the filler. The problem is reduced to solving the system of equations, finding the relationship between the elastic parameters of the foamlex and its unit weight, and selecting the plates having the minimum weight at a given loading parameter. M.G.J.

N67-20033*# Israel Program for Scientific Translations, Ltd., Jerusalem.

ON THE DEPENDENCE OF THE UPPER CRITICAL PRESSURE OF A CYLINDRICAL SHELL ON THE BOUNDARY CONDITIONS FOR THE TANGENTIAL DISPLACEMENTS

N. A. Alfutov *In its* Theory of Shells and Plates 1966 p 167–172 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Based on an analysis of the buckling of a schematized semimomentless shell, an assessment is made of the influence of the boundary conditions for the tangential displacements on the value of the upper critical pressure of a closed circular cylindrical shell. Several special variants of the boundary conditions are considered: (1) both ends of the shell are simply supported; (2) both ends of the shell are hinged; (3) one end is simply supported, the other is hinged; (4) one end is hinged, the other is free; (5) one end is simply supported, and the other cannot move in the axial direction; (6) one end is hinged, and the other cannot move in the axial direction; and (7) one end is simply supported, the other is free. It is concluded that the allowance for the boundary conditions for the tangential components of the displacements considerably influences the value of the upper critical pressure. This influence is particularly strong for shells with one free end. M.G.J.

N67-20034*# Israel Program for Scientific Translations, Ltd., Jerusalem.

MOTION OF A RIGID-PLASTIC CIRCULAR CYLINDRICAL SHELL IN A RESISTING MEDIUM

A. A. Amandosov *In its* Theory of Shells and Plates 1966 p 173–179 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

In this analysis, it is assumed that the shell is made of a rigid ideally plastic material behaving according to Tresca's yield condition and to the corresponding flow rule. It is also assumed that the shell is subjected to a uniformly distributed impact load of constant intensity, and that the resistance force is proportional to the first power of the displacement velocity. Fundamental equations of motion are formulated and applied to solving the case of the medium value of the load, and to the problems of a short shell under a medium load and a long shell under a medium load. It is shown that the influence of the medium resistance on the deflection value is considerable even for a medium value of the load. M.G.J.

N67-20035*# Israel Program for Scientific Translations, Ltd., Jerusalem.

DYNAMICS OF A MOMENTLESS SPHERICAL SHELL MADE FROM AN IDEALLY RIGID-PLASTIC MATERIAL

A. I. Babichev *In its* Theory of Shells and Plates 1966 p 180–184 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

The motion of a semispherical momentless shell with built-in edges is analyzed, and the stress–strain diagram of the rigid plastic

material is presented. The material is assumed to behave according to Mises' yield condition and to the flow rule connected with it. An axially symmetrical normal pressure is applied to the shell at the initial time moment. It is assumed that the material of the entire shell, or of a part of the shell, passes instantaneously into a plastic state. In formulating the equations of motion, large deflections are taken into account; the method of successive approximations is used for the solutions. M.G.J.

N67-20036*# Israel Program for Scientific Translations, Ltd., Jerusalem.

STABILITY OF AN ORTHOTROPIC CYLINDRICAL SHELL IN A GAS STREAM

Zh. E. Bagdasaryan *In its* Theory of Shells and Plates 1966 p 185–192 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

In the problem considered, the assumption is made that a supersonic gas stream flows past a thin cylindrical shell at an undisturbed velocity directed parallel to the shell generator. It is also assumed: (1) The shell consists of an odd number of homogeneous anisotropic layers arranged symmetrically relative to the coordinate surface of the shell. Each layer has the same thickness and the same physico-mechanical properties. (2) The coordinate surface is the middle surface of both the middle layer and the shell as a whole. (3) The material of each layer behaves according to the generalized Hooke law. At each point there are three planes of elastic symmetry, the principal directions of which coincide with those of the orthogonal coordinate lines. (4) The shell layers remain elastic after deformation and do not slip relative to each other. (5) The hypothesis of undeformable normals is true for the whole sandwich shell. Formulas are given for the equations of motion, the elasticity relationships, and the geometrical relationships. Also considered are the stability of an orthotropic sandwich shell, and the influence of anisotropy and nonhomogeneity on the critical velocity of the flutter. M.G.J.

N67-20037*# Israel Program for Scientific Translations, Ltd., Jerusalem.

STUDY OF THE STABILITY OF ELASTIC RECTANGULAR PLATES WITH A RECTANGULAR HOLE BUILT-IN BY THE OUTER AND INNER CONTOURS

A. Baratov *In its* Theory of Shells and Plates 1966 p 193–199 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Consideration is given to three cases of loading with forces applied to the outer contour of the rectangle only, and with stresses not exceeding the elastic limit. These are: (1) simultaneous action of compressive forces directed perpendicular to the rectangle sides; (2) plate compression in the direction of one pair of sides of the rectangle only; and (3) plate compression in the direction of one pair of sides of the rectangle, and extension in the direction of the other pair. Also studied is the influence of the ratio of the loads and the ratio of the sides on the stability coefficient of plates with rectangular hole built-in by both the outer and inner contours. The problem is solved by the method of finite differences in a dimensionless form. Author

N67-20038*# Israel Program for Scientific Translations, Ltd., Jerusalem.

NONLINEAR INTEGRAL AND INTEGRAL–DIFFERENTIAL EQUATIONS OF SHALLOW SHELLS AND THEIR APPLICATIONS

A. A. Berezovskii *In its* Theory of Shells and Plates 1966 p 200–206 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

The determination of the stressed and strained state of flexible shells and plates is reduced to the solution of nonlinear boundary value problems, which in turn are reduced to an equivalent system of nonlinear integral equations. Approximate solution methods are applied to these equations, and a system of nonlinear algebraic equations is obtained. Several specific cases are considered, involving the problems of (1) large deflections and buckling of a simply supported circular plate under the action of a normal load of intensity, a compressive force, and a bending moment uniformly distributed over the contour; (2) large deflections of a simply supported shallow spherical shell under the action of a normal load of intensity, and a bending moment distributed uniformly over the contour; and (3) of large deflections and buckling of a shallow shell of double curvature under the action of compressive forces and bending moments. For cases where it is impossible to form the linear solution, an approximate linear solution is established. M.G.J.

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ON THE SYMMETRICAL DEFORMATION OF AN ORTHOTROPIC TOROIDAL SHELL

Yu. D. Bessarabov and M. A. Rudis *In its* Theory of Shells and Plates 1966 p 207–215 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Based on the equations of symmetrical deformation of anisotropic shells, a solution is proposed to the problem of similar deformation in an orthotropic toroidal shell. A resolving equation is obtained which contains a small parameter, proportional to the shell thickness, at a high order derivative. This equation is solved by the asymptotic method, which is described in detail. Simple formulas are then given for determining the maximum stresses and strains in the shell. Author

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THERMAL STRESSES IN A REINFORCED CYLINDRICAL SHELL

L. A. Bordunova *In its* Theory of Shells and Plates 1966 p 216–220 ref (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

A solution is given to the problem of determining the temperature stresses and displacements in a cylindrical shell reinforced by stringers in the case of axisymmetrical heating. The temperature is assumed to be constant through the shell thickness and to vary along its length according to some arbitrary law. The temperature of the stringers can vary in both directions (length and height); however, it is assumed that its variation with height is linear. The temperature field is assumed to be stationary, the material of the shell and stringers to be elastic and isotropic, and the physical–mechanical characteristics of the material to be temperature-independent. The problem is solved in an exact formulation, as a contact problem. The displacements and stresses in the shell are determined first, and the displacements and stresses in the stringer afterwards. Author

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DYNAMIC CONTACT PROBLEM FOR A THICK PLATE IN THE CASE OF AXIAL SYMMETRY

N. M. Borodachev *In its* Theory of Shells and Plates 1966 p 221–226 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

The problem of the motion of a punch under the action of a dynamic force is considered. Initially, a general solution is established to the problem of steady vibrations of an elastic layer of finite thickness lying on a rigid foundation in the case of axial symmetry. The results are applied to solving the dynamic contact problem for an infinitely thick elastic plate laying without friction on a rigid foundation, which is subjected to the action of a

circular–cylindrical punch with flat base, advancing under the action of an axial force. It is assumed that there is no friction between the punch and the plate, and that there is no load outside the punch. M.G.J.

N67-20042*# Israel Program for Scientific Translations, Ltd., Jerusalem.
VIBRATIONS OF CYLINDRICAL SHELLS FILLED WITH LIQUID
V. E. Breslavskii *In its* Theory of Shells and Plates 1966 p 227–232 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

In examining the free vibrations of smooth and ribbed cylindrical shells partially or completely filled with liquid, it is assumed that the cylinder is filled with a completely uncompressible liquid which performs a potential motion during the cylinder vibrations. The vibrations of a shell with simply supported edges is considered. The equations of motion and the shell vibrations, the boundary conditions, and the displacements are formulated. An empirical determination of the natural frequencies of a cylindrical steel shell filled with water was used to test the formulas obtained. Results of the experimental determination of the frequencies of the full and empty shell are tabulated, together with the corresponding calculated values. It is shown that the calculated values are quite near to the experimental ones. M.G.J.

N67-20043*# Israel Program for Scientific Translations, Ltd., Jerusalem.
PRINCIPLES OF THE STABILITY CALCULATIONS OF THIN SHELLS
B. M. Broude *In its* Theory of Shells and Plates 1966 p 233–240 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

In assessing the influence of a sufficiently small initial curvature on the lower critical load of the elastic shell, only geometrical nonlinearity is considered. Approximate estimates are obtained by forming majorants (minorants) of the solution of the related system of nonlinear equations. To determine the critical load in the case of plastic buckling of a shell with initial curvature, the problem is treated in a geometrically linear formulation; however, allowance is made for the physical nonlinearity with the diagram of the elastic–plastic material used. The initial curvature is assumed to be axially symmetrical and similar in form to the buckling of an ideal shell. The approximate values of the critical stress are found under two assumptions: (1) the modulus of elasticity in the circumferential direction remains constant; and (2) this modulus decreases with the passage of the meridional stresses beyond the elastic limit. The acceptability of the geometrical linearization in determining the critical load is proved. M.G.J.

N67-20044*# Israel Program for Scientific Translations, Ltd., Jerusalem.
BENDING OF SANDWICH PLATES ALLOWING FOR TEMPERATURE STRESSES
L. E. Bryukker *In its* Theory of Shells and Plates 1966 p 241–245 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Formulas are given for the static derivation of the linear equations of longitudinal–transverse bending of nonsymmetrical sandwich plates with rigid filler. Allowance is made for nonuniform heating. It is assumed: (1) The three layers of the plate consist of different isotropic materials. The moduli of elasticity of the faces and of the layers are assumed to be constant; the fillers vary through the thickness. (2) The Poisson ratios are constant and equal to each other. The broken-line hypothesis is used for the distribution of stresses through the plate thickness. Under the hypotheses made, the relationships between the displacements and the stresses are formulated. It is noted that when the filler is assumed to be undeformable in the transverse direction, the redistribution of stresses between the layers, due to the temperature gradient through the plate thickness, does not influence the critical loads for the plate. M.G.J.

N67-20045*# Israel Program for Scientific Translations, Ltd., Jerusalem.
STABILITY OF STRUCTURALLY ORTHOTROPIC CYLINDRICAL PANELS UNDER THE ACTION OF SHEARING AND NORMAL FORCES AND INTERNAL PRESSURE
E. F. Burmistrov and A. A. Mel'nichenko *In its* Theory of Shells and Plates 1966 p 246–253 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Various approximation methods are examined as possible approaches to determining stability. Among the cases considered are: (1) a shallow structurally orthotropic cylindrical panel stretched along the generatrix; (2) a structurally orthotropic cylindrical panel, considered as a strip, which is stretched along the generatrix and subjected to loading; and (3) the stability of a cylindrical strip stretched along the generatrix. In each case, the problem is reduced to the integration of a system of equations. M.G.J.

N67-20046*# Israel Program for Scientific Translations, Ltd., Jerusalem.
APPLICATION OF THE METHOD OF LAGRANGE MULTIPLIERS IN THE STUDY OF THE STABILITY OF PLATES AND SHELLS
A. A. Bushtyrkov *In its* Theory of Shells and Plates 1966 p 254–261 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Solutions to several problems of elastic stability are presented, based on the use of Lagrange multipliers. The cases considered involve the stability of (1) a bar with one end built-in and the other hinged; (2) a rectangular plate built-in along two opposite edges and simply supported along the other two, compressed in the direction of the supported edges by uniformly distributed forces; and (3) an orthotropic cylindrical shell with built-in edges subjected to external pressure. M.G.J.

N67-20047*# Israel Program for Scientific Translations, Ltd., Jerusalem.
STUDY OF MEDIUM AND LARGE DEFLECTIONS OF SHALLOW SPHERICAL SEGMENTS UNDER ARBITRARY AXISYMMETRICAL LOADS
D. L. Bykov *In its* Theory of Shells and Plates 1966 p 262–268 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

The problem of the axisymmetric elastic deformation of a shallow spherical segment is reduced to solving a system of equilibrium equations. Two nonlinear equations are obtained relative to the displacements of the meridional and circumferential forces per unit length, and variations of the curvature, and the meridional displacement. The method of successive approximations is used to determine the medium deflections. For large deflections, the Bubnov–Galerkin method is used. As an application of this method, the case of loading of the segment by a circumferential distributed pressure is examined. M.G.J.

N67-20048*# Israel Program for Scientific Translations, Ltd., Jerusalem.
ITERATIVE ALGORITHMS AND NUMERICAL PROBLEMS OF THE THEORY OF PLATES AND SHELLS
D. V. Vainberg, A. L. Sinyavskii, and E. S. Dekhtyaryuk *In its* Theory of Shells and Plates 1966 p 269–274 ref (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

The problem of determining the algorithm of the numerical solution of a wide class of systems of discrete equations pertaining to the elasticity theory is discussed in relation to the efficient use of digital computers. The limited volume of the computer memory was considered, and it was found that methods in which the equations are not transformed in the course of the calculations are best suited for computer problem solving. A program based on the iterative method was worked out, suitable for solving a wide variety of problems, differing by the type of equations, the configuration of the region, the boundary conditions, and other initial parameters. Based on a detailed study of the algorithm structure, the program is split into blocks with each block fulfilling a specific function. The program is based on the class of iterative algorithms called descent methods; a brief geometrical exposition of the method is presented. It is reported that the two-dimensional problem for a double-connected region was solved by iterations, and that the problem of calculating warped plate systems was programmed. M.G.J.

N67-20049*# Israel Program for Scientific Translations, Ltd., Jerusalem.

VIBRATIONS OF SHALLOW SPHERICAL SHELLS

G. A. Van Fo Fy and V. N. Buivol *In its* Theory of Shells and Plates 1966 p 275–278 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

The system of equations of transverse vibrations of a shallow spherical shell is derived to express the relations of stress function, deflection, radius and thickness of the shell, the specific gravity and modulus of elasticity of the shell material, the flexural rigidity, the disturbing force normal to the surface, the Laplacian in polar coordinates, and time. Harmonic vibrations are considered to reduce the system, and separate equations are obtained for the stress function and the deflection. Equations are also formulated for the case of axial symmetry when the disturbing force is applied at the top of the shell. M.G.J.

N67-20050*# Israel Program for Scientific Translations, Ltd., Jerusalem.

ON THE THEORY OF CALCULATING PLATES ON AN ELASTIC FOUNDATION

V. V. Vardanyan *In its* Theory of Shells and Plates 1966 p 279–285 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

A method is proposed for determining the values of two foundation moduli k and t, which enter into the expression for the elastic reaction of the foundation. It is assumed that the foundation is an elastic half-space, and the parameters k and t are determined from the condition that the results of the calculation diverge as little as possible from the results given by the theory based on the elastic half-space hypothesis. As an example, consideration is given to a circular plate of radius a lying on an elastic foundation and loaded by an arbitrary axisymmetrical load, and to a cylindrical circular punch of the same radius a with a spherical base of radius R. When such a punch is pressed in the elastic half-space by a force P, the magnitude of the latter can be selected so that elastic reactions of infinite magnitude appear on the punch edges. Solutions are given for the cases of pure bending and for arbitrary axisymmetrical transverse loading. M.G.J.

N67-20051*# Israel Program for Scientific Translations, Ltd., Jerusalem.

ON THE SOLUTION OF THE PROBLEM OF STRESS CONCENTRATION AROUND A CIRCULAR HOLE IN A SPHERICAL SHELL IN THE ELASTIC–PLASTIC DOMAIN

V. V. Vasil'ev *In its* Theory of Shells and Plates 1966 p 286–290 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

The numerical solution proposed for the problem of the axisymmetrical elastic–plastic stressed and strained state around a reinforced circular hole in a thin spherical shell is based on the theory of small elastic–plastic deformations and the method of elastic solutions. The differential equations are written in displacements and are integrated by the method of finite differences. It is assumed that the shell material is work-hardening to an arbitrary extent. It is shown that the propagation of the zone of disturbance of the stressed and strained state is restricted and bears a local character in both the elastic and elastic–plastic states of the structure. A considerable deviation from the fundamental membrane state of the shell was observed in the plastic and the elastic–plastic regions. The stressed and strained state in the elastic region of the shell is near to a membrane state. Author

N67-20052*# Israel Program for Scientific Translations, Ltd., Jerusalem.

SOME PROBLEMS OF CALCULATING LARGE-PANEL EDIFICES AND EDIFICES MADE OF VOLUME ELEMENTS AS THREE-DIMENSIONAL SYSTEMS

B. S. Vasil'kov *In its* Theory of Shells and Plates 1966 p 291–299 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Based on the theory of shells and the variation method, a general calculation technique is proposed which takes into account the strains of the transverse compression of the longitudinal and lateral walls, in addition to the shearing strains and the longitudinal elongations. The building is considered as a prismatic body of multiconnected section, built in the general case on a yielding foundation. Its vertical and horizontal sides represent continuous plates of reduced thickness at longitudinal extension–compression, at shear in their own plane, and at transverse compression. The system of differential equations for calculating the building box as a three-dimensional system is established allowing for the joint response under strain of the system building plus elastic foundations, with the elastic foundation considered as an elastic layer of finite height. As an example of the method, calculations are given for a building at bending by the beam scheme with a design span $l = 27.3$ m. M.G.J.

N67-20053*# Israel Program for Scientific Translations, Ltd., Jerusalem.

ON ONE SOLUTION OF THE THEORY OF BENDING

V. V. Vlasov *In its* Theory of Shells and Plates 1966 p 300–306 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

A direct method is described for obtaining solutions to the two-dimensional problem of the theory of elasticity. This corresponds to problems of equilibrium of flat plates with arbitrary static conditions on planes $z = \pm h/2$, with the boundary conditions on the lateral surface of the plate satisfied in the Saint Venant sense. It is noted that all solutions of the theory of elasticity in polynomials were obtained, corresponding to the antisymmetrical state of equilibrium of the plate relative to plane $z = 0$. A solution is also presented to the boundary value problem in the Saint Venant sense in the three-dimensional case; for thin plates, the solution corresponds to the two-dimensional problem of bending of plates. As an example, a rectangular plate supported along the contour and subjected to the action of a normal uniformly distributed load is considered. M.G.J.

N67-20054*# Israel Program for Scientific Translations, Ltd., Jerusalem.

STRESSED–STRAINED STATE OF A TOROIDAL SHELL AT BENDING, APPLICABLE TO CALCULATING BELLOWS

A. N. Volkov *In its* Theory of Shells and Plates 1966 p 307–315 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Several cases are examined, for which it is considered possible to develop a simple algorithm to calculate a closed toroidal shell with two edges. One edge contains a singular line, subjected to a wind-type load. The method of so-called standard solutions is used, which consists in reducing the system of equations to one equation of the same order and the same singularities. It is pointed out that the presence of an edge coinciding with a singular line introduces a considerable distortion in the stressed–strained state of the shell in the region near this edge. In addition, the stressed states become mixed and can no longer be separated. M.G.J.

N67-20055*# Israel Program for Scientific Translations, Ltd., Jerusalem.
CONTACT PROBLEM FOR FOUNDATIONS SUBJECTED TO BENDING STRAINS
I. I. Vorovich and V. V. Kopasenko *In its* Theory of Shells and Plates 1966 p 316–324 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

The action of an elastic axisymmetrical punch on a layer of finite thickness h supported along a ring is considered. The friction forces between the punch and the layer are neglected. An approximate solution is obtained, correct for h not smaller than the diameter 2a of the contact zone. Author

N67-20056*# Israel Program for Scientific Translations, Ltd., Jerusalem.
CALCULATION OF A CYLINDRICAL SHELL REINFORCED BY ELASTIC STIFFENERS UNDER THE ACTION OF A CONCENTRATED FORCE
S. I. Galkin *In its* Theory of Shells and Plates 1966 p 325–334 ref (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

A solution is presented to the problem of the stressed–strained state of a circular cylindrical shell reinforced by stiffeners, when the shell edge is loaded by an arbitrary system of shearing and axial forces. It was assumed that the sheathing behaves as a thin shell acted upon by membrane stresses subjected to axial and shearing forces; the Poisson ratio of the sheathing is taken as equal to zero; the stiffeners have a finite flexural rigidity in their plane and a zero flexural rigidity out of their plane. The stiffeners are assumed to be continuously connected along the contour with the sheathing; the radius of the neutral axis of the stiffener is equal to the radius of the middle surface of the sheathing. This solution is then applied to the stressed and strained state of a circular reinforced cylindrical shell for different cases of loading of the shell edge, including the action of concentrated forces. It is sufficient to find the expansion coefficients of the given functions in the Fourier series. M.G.J.

N67-20057*# Israel Program for Scientific Translations, Ltd., Jerusalem.
PROBLEMS OF THE THEORY OF PNEUMATIC SHELLS
G. A. Geniev *In its* Theory of Shells and Plates 1966 p 335–338 (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

The geometrical shape of a closed singly connected pneumatic shell of revolution made of a strongly extensible ideally elastic material under a statically increasing internal pressure is investigated mathematically. It is assumed that the initial shape of the shell surface is known, that only tensile stresses appear in it under the action of the internal pressure, and that a momentless state of stress of the shells exists. The differential equations for the shells of revolution made from an ideally elastic material are discussed. The problem of the deformation of a shell whose initial surface is formed by the rotation of an ellipse relative to one of its major axes is considered. The relationship determining the displacements of the physically fixed points of the shell surface are presented, and the limiting parameters are included. N.E.N.

N67-20058*# Israel Program for Scientific Translations, Ltd., Jerusalem.
FREE VIBRATIONS OF CIRCULAR CONIC SHELLS
V. G. Godzevich *In its* Theory of Shells and Plates 1966 p 339–343 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Based on the established fact that there is generally a multiwave pattern of deformation corresponding to free nonsymmetrical vibrations of shells of zero curvature, equations are developed for shells with large index of variability in both principle directions. Expressions are presented for the frequencies of natural vibrations of conic shells at any number of half-waves in the transverse direction, and also for the frequencies in the transverse direction with only one half-wave in the longitudinal direction. The results are compared with data obtained experimentally by subjecting a number of conical shells to special tests on an electromagnetic vibrostand. N.E.N.

N67-20059*# Israel Program for Scientific Translations, Ltd., Jerusalem.
CLINGING OF PANELS UNDER THE ACTION OF RANDOM FORCES
V. M. Goncharenko *In its* Theory of Shells and Plates 1966 p 344–351 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

The vibratory motion of flexible shells under the action of random forces is discussed. Expressions are developed for the nonclassical buckling occurring during transition from one equilibrium condition to another in the load range between the upper and lower critical values. The statistical characteristics of multiple buckling are considered, and the Markow processes are used in solving the problem. N.E.N.

N67-20060*# Israel Program for Scientific Translations, Ltd., Jerusalem.
ON THE BEHAVIOR OF FABRIC SHELLS UNDER LOAD
V. N. Gordeev *In its* Theory of Shells and Plates 1966 p 352–359 (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

As the intersecting flexible threads usually form a dense net, the shell material is considered as compact and resistant only to forces acting along the threads. In examining shallow shell behavior, three simplifying assumptions are made: (1) The relative elongations of the material are negligibly small compared with unity. (2) The horizontal displacements of the shell points are so small that they can be neglected when studying the equilibrium of a shell element. This is realized in the case of shells shallow relative to the horizontal plane, if each thread has at least one point fixed in the longitudinal direction. (3) The rotations of the shell elements during its deformation are so small that the squares of the rotation angles can be neglected when studying the equilibrium of the elements, and the higher powers of these angles when studying the geometrical relationships. This assumption requires a sufficient rigidity. A system of differential equations describing the behavior of a tissue shell under a static load is derived, based on these assumptions. M.G.J.

N67-20061*# Israel Program for Scientific Translations, Ltd., Jerusalem.
APPROXIMATE CALCULATION OF LINKED THICK CYLINDRICAL SHELLS AND PLATES
F. A. Gokhbaum *In its* Theory of Shells and Plates 1966 p 360–366 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

A three-step approach is described for approximately calculating compound structures, such as a hydraulic cylinder with

bottom made of prestressed reinforced concrete. The solution to the axisymmetrical problem of the elasticity theory for a shallow cylinder is applied to the calculation of a thick cylindrical shell. The method of initial functions is used in deriving the approximate computing formulas. For calculating a thick circular plate, use is made of the set of homogeneous solutions for a continuous cylinder with an unloaded lateral surface and axisymmetrically loaded ends. As these solutions contain arbitrary constants, which have to be determined from the conditions of linking the elements by the ends, any method leading to a system of algebraic equations for determining the unknown arbitrary constants can be used for calculating the link. The method of orthogonalization is considered to satisfy this requirement. M.G.J.

N67-20062*# Israel Program for Scientific Translations, Ltd., Jerusalem.

SOME THEORETICAL AND EXPERIMENTAL INVESTIGATIONS OF SELF-OSCILLATIONS OF CURVED PANELS IN A GAS STREAM

E. I. Grigolyuk, R. E. Lamper, and L. G. Shandarov *In its* Theory of Shells and Plates 1966 p 367–371 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

The problems involved in the various approaches taken to calculating short shells and shells reinforced by elastic stiffeners are discussed. It is pointed out that in the case of long shells two terms are sufficient for an approximate solution, and four give a practically exact result. However for short shells, in which two forms with frequencies lying in the region of very dense frequency spectrum are allowed for in the two-term approximation, the influence of the neglected forms can be considerable. Therefore, the basic characteristic of the calculation of short shells is the necessity to take into account a larger number of terms, which leads to a higher order determinant. Initial results of experiments on self-oscillations of cylindrical panels in a supersonic pipe are also presented. M.G.J.

N67-20063*# Israel Program for Scientific Translations, Ltd., Jerusalem.

ON THE LARGE DEFLECTIONS AND STABILITY OF REINFORCED CONCRETE SHALLOW FLEXIBLE SHELLS ALLOWING FOR THE CREEP OF CONCRETE

G. S. Grigoryan *In its* Theory of Shells and Plates 1966 p 372–382 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Deflection equations and Lyapunov stability equations are worked out for a body made of reinforced concrete bars, plates, and shells as a sandwich (diagram is given), made of an isotropic concrete layer and two isotropic symmetrical reinforcing faces fastened reliably to each other (without the possibility of sliding along the surfaces of contact). The faces of the sandwich are assumed to behave elastically, and it is also assumed that the concrete layer has a linear creep, with equal Poisson ratios of the elastic and inelastic parts of the deformation and equal modulus of elasticity and measure of creep of the concrete at extension and compression. L.S.

N67-20064*# Israel Program for Scientific Translations, Ltd., Jerusalem.

STRESSED STATE OF A CIRCULAR THICK DISK IN A FIELD OF CENTRIFUGAL FORCES

V. T. Grinchenko *In its* Theory of Shells and Plates 1966 p 383–388 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Mathematical relationships satisfying the boundary conditions for the normal and shearing stresses (obtained from expressions from Hooke's law) are presented and used to find a solution to Lame's equations which in turn are used to work out a rigorous solution to the problem of the stressed state of a circular thick disk in a field of centrifugal forces. The solution to the stressed state of an infinite system is also presented. L.S.

N67-20065*# Israel Program for Scientific Translations, Ltd., Jerusalem.

APPROXIMATE SOLUTIONS OF SEVERAL PROBLEMS OF STRESS CONCENTRATION ABOUT HOLES IN ISOTROPIC AND ORTHOTROPIC SHELLS

A. N. Guz' *In its* Theory of Shells and Plates 1966 p 389–394 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

An approach to the study of stress concentration about holes proposed by Savin, in which the stressed state of the shell is represented as the sum of the stressed state of a shell without hole and the disturbances caused by the presence of a hole, is used to study the stress concentration in isotropic shells about quasi-circular holes; the stress concentration about a circular hole reinforced by an absolutely rigid pipe socket in a cylindrical orthotropic shell; and the stress concentration about a curvilinear hole in a spherical shell. Detailed calculations are presented. L.S.

N67-20066*# Israel Program for Scientific Translations, Ltd., Jerusalem.

ON THE NONLINEAR VIBRATIONS OF ELASTIC SHELLS UNDER RANDOM LOADS

M. F. Dimentberg *In its* Theory of Shells and Plates 1966 p 395–401 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Systems of equations treating the probability density of the extreme values of the deflections and stresses in the case of nonlinear vibrations of elastic shells under random loads are presented. The motion of an elastic shallow rectangular shell is described by a system of two equations (Markov process and Fokker–Planck–Kolmogorov equations) in partial derivatives (the tangential inertia forces are neglected). L.S.

N67-20067*# Israel Program for Scientific Translations, Ltd., Jerusalem.

USE OF DIGITAL COMPUTERS IN THE CALCULATION OF SMOOTH AND RIBBED PLATES AND SHELLS, EITHER NOT STRESSED OR STRESSED BY HOLES

M. I. Dlugach and A. I. Shinkar' *In its* Theory of Shells and Plates 1966 p 402–408 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

The method of group elimination of unknowns was programmed; and two standard programs for the BESM computer were worked out, suitable for problems involving smooth and ribbed plates and shells, either stressed or not stressed by holes. One program corresponds to the case of symmetrical equation systems of three-cell structure (either bordered by some additional columns and rows or unbordered); and the second program corresponds to equation systems of five-cell structure. The programs contain a special subprogram for the introduction of input data. Several problems have been solved by use of the programs, and one case concerning a rectangular plate bordered by ribs-beams only is presented. The problem is depicted in a diagram; and the system of equations used is represented in tables in the form of a cellular matrix. L.S.

N67-20068*# Israel Program for Scientific Translations, Ltd., Jerusalem.

A NONSTATIONARY TEMPERATURE PROBLEM RELATIVE TO A CYLINDRICAL SHELL STIFFENED BY A RING

S. M. Durgar'yan *In its* Theory of Shells and Plates 1966 p 409–417 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

The state of stress and strain of structures such as thin-walled stiffened cylindrical shells working in a temperature field varying monotonically along the cylinder generator, is studied. The problem is solved in a linear formulation in the frame of the generalized Hooke law, without allowing for the creep of the material. Diagrams of the problem are presented; and fundamental equations used for solution of the problem are derived. The structures considered are finding an increasing application in engineering practice. L.S.

N67-20069*# Israel Program for Scientific Translations, Ltd., Jerusalem.

THE TWO-DIMENSIONAL PROBLEM FOR A HELICOIDAL SHELL

V. K. Zalesskii *In its* Theory of Shells and Plates 1966 p 418–423 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

The moments, forces per unit length, and displacements characterizing the state of stress and strain of a two-dimensional helicoidal shell of uniform thickness, are determined. Fundamental equations of the theory of thin shells are presented, and the geometrical parameters of the helicoid equations are substituted in them. Equations of compatibility of strains in forces per unit length and moments in Novozhilov's form; equations of elasticity; and formulas connecting the displacements with the strains are given. L.S.

N67-20070*# Israel Program for Scientific Translations, Ltd., Jerusalem.

DETERMINING GREEN'S FUNCTION FOR A PLATE OF VARIABLE THICKNESS, RECTANGULAR IN THE PLAN

G. A. Izdebskaya *In its* Theory of Shells and Plates 1966 p 424–430 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

A reciprocal theorem is used to determine Green's function for a plate of variable thickness, rectangular in the plan. The function normally represents the deflection of a rectangular plate of uniform thickness. Systems of equations for the equilibrium involved, the loads and displacements, are presented. The kernel of the plate is represented through theta functions, which are expressed by rapidly converging series, making it possible to avoid the use of the diverging series obtained in Navier's solution of the problem. L.S.

N67-20071*# Israel Program for Scientific Translations, Ltd., Jerusalem.

STRESS CONCENTRATION IN THIN ELASTIC SPHERICAL SHELLS

L. B. Imenitov *In its* Theory of Shells and Plates 1966 p 431–434 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

The problem of stress concentration about an arbitrarily located nonreinforced circular hole in a thin elastic domelike spherical shell with a built-in edge passing along a parallel of the geographical system of coordinates, is solved by finding the membrane stressed state. Factors such as the purely moment stress state (a special study on this was conducted), the edge effect by the hole, and the rapidly varying stressed state, are neglected because of the low intensity of forces produced by them. L.S.

N67-20072*# Israel Program for Scientific Translations, Ltd., Jerusalem.

ON THE CALCULATION OF NONLINEAR VIBRATIONS OF FLEXIBLE PLATES AND SHALLOW SHELLS BY THE SMALL PARAMETER METHOD

V. S. Kalinin *In its* Theory of Shells and Plates 1966 p 435–443 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

A mathematical scheme for calculating the periodic vibrations of flexible shallow shells and plates, similar to a technique used earlier for calculating the nonlinear vibrations of bars, is presented. The solution to the problem is found from equations allowing for all the linear and nonlinear boundary conditions, and the method of the small parameter is incorporated in the equations used in finding the solution. Theoretical curves plotted from formulas of the scheme, representing the lower frequencies of the shells considered, are depicted. L.S.

N67-20073*# Israel Program for Scientific Translations, Ltd., Jerusalem.

LOAD-CARRYING CAPACITY OF CIRCULAR CYLINDRICAL SHELLS AT COMPRESSION

S. N. Kan *In its* Theory of Shells and Plates 1966 p 444–449 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

The physical clarity of the proposed interpretation of the structure behavior, the simplicity of the derivation of the computing relationships and of the plotting of the curves of strength and stability of the shell, and the practically perfect coincidence with the results of the experiments and calculations by the relatively complex method of Donnell and Wan speak for themselves in favor of the solution proposed. It is also noted that, since the lateral load is equivalent, from the point of view of the stressed state, to some initial deflection, the method for calculating the load-carrying capacity proposed here applies directly to this type of load as well. The lateral load can sharply reduce the load-carrying capacity of the shell in those cases when the initial deflection equivalent to its approaches the critical harmonic. It is at the same time obvious that large local dents can influence only weakly the load-carrying capacity, if they have an irregular pattern. Author

N67-20074*# Israel Program for Scientific Translations, Ltd., Jerusalem.

FREE VIBRATIONS OF A CYLINDRICAL SHELL WITH STIFFENING RIBS

N. I. Karpov *In its* Theory of Shells and Plates 1966 p 450–454 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

A method of solving the problem of free vibrations of a cylindrical shell reinforced by stringers, allowing for the discrete arrangement of the latter on the shell, is proposed. The systems of equations used in the method are presented. The studies lead to the following conclusions: (1) The spectrum of natural frequencies of the shell is complete; (2) If the fundamental frequency of the reinforcing stringers is larger (or smaller) than the fundamental frequency of the shell which is to be reinforced, the fundamental frequency of the resulting reinforced shell will likewise be larger (smaller) than the latter; (3) The larger the number of stringers, the nearer the fundamental frequency of the reinforced shell to the fundamental frequency of the stringer; (4) The spectrum of natural frequencies of the shell is sufficiently dense, and becomes even denser after its reinforcement by the stringers. L.S.

N67-20075*# Israel Program for Scientific Translations, Ltd., Jerusalem.

POST-BUCKLING STATE AND STRESS CONCENTRATION IN ANNULAR PLATES

Ya. F. Kayuk *In its* Theory of Shells and Plates 1966 p 455–459 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

The stress concentration on the free contour of an annular plate of inner radius b and outer radius a (with inner contour free, and outer contour either hinged or rigidly clamped) is determined in the post-buckling elastic asymmetrical state, after a normal compressive force per unit length P is applied to the outer contour.

Systems of equations are presented for the appropriate boundary conditions; and the solution to examples (one in which the outer edge is hinged, the other in which the outer edge is built in) are worked out. L.S.

N67-20076*# Israel Program for Scientific Translations, Ltd., Jerusalem.

STUDY OF THE STRESSED STATE OF RIBBED SHELLS WITH ZERO GAUSSIAN CURVATURE

G. A. Kizima *In its* Theory of Shells and Plates 1966 p 460–467 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

The stressed state of a shell of zero Gaussian curvature, provided with ribs arranged along the generators at equal distance from each other along the directrix, is represented as a superposition of the symmetrical stressed state of the shell without ribs under the given external load and of the nonsymmetrical stressed state (the disturbance introduced by the ribs). Systems of equations for determining the forces and displacements are presented for three different conditions of loading for both cylindrical and conical shells. L.S.

N67-20077*# Israel Program for Scientific Translations, Ltd., Jerusalem.

INTEGRAL–DIFFERENTIAL EQUATIONS OF SHELL EQUILIBRIUM WITH FOCUSING KERNELS

N. A. Kil'chevskii and N. I. Remizova *In its* Theory of Shells and Plates 1966 p 468–473 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

The advantage of this system of equations is that when the system is approximately replaced by a system of algebraic equations it becomes possible to pick out the dominant terms in the equations and to work out approximate methods of solution, similar to the Gaussian method of solving systems of linear algebraic equations. An example is presented for the equilibrium of a circular cylindrical panel with contour elastically supported at four corner points under the action of a normal concentrated force. The boundary conditions satisfied by the fundamental state are given. In addition to a scheme for the numerical solution of the algebraic system for the auxiliary load of the shell, an interpolation–iterative method for solving the system is outlined. L.S.

N67-20078 Israel Program for Scientific Translations, Ltd., Jerusalem.

DYNAMIC INSTABILITY OF CIRCULAR CYLINDRICAL SHELLS SUBJECTED TO LONGITUDINAL COMPRESSIVE STRESSES IN THE CASE OF THERMOPARAMETRIC RESONANCE

G. A. Kil'chinskaya *In its* Theory of Shells and Plates 1966 p 474–481 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

The stability of cylindrical shells subjected to the simultaneous action of a longitudinal compressive force and a temperature field, both periodic in time, is analyzed for the case of temperature-dependent coefficient of linear thermal expansion and modulus of elasticity. The formulas obtained from the system of equations used indicate that the parametric influence of the temperature field can increase the value of the critical forces per unit length. The examples considered point to the existence of qualitatively new dynamic processes, depending on the inertial terms in the equations of thermoelasticity of the shells and on the temperature variation of the modulus of elasticity and the coefficient of linear thermal expansion. There is a possibility of not only allowing for the parametric influence of the temperature field in the dynamic equations, but also of generalizing the results obtained to the case of high heating temperatures. L.S.

N67-20079*# Israel Program for Scientific Translations, Ltd., Jerusalem.

CALCULATION OF RECTANGULAR ORTHOTROPIC PLATES LYING ON AN ELASTIC FOUNDATION WITH TWO FOUNDATION MODULI AND SUBJECTED TO STATIC AND PULSATING LOADS

V. A. Kiselev *In its* Theory of Shells and Plates 1966 p 482–494 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Differential equations for the bending, and expressions of the internal forces occurring in rectangular orthotropic plates lying on an elastic foundation, with two foundation moduli, and subjected to either static or pulsating loads, are presented. The method of initial parameters is used for the calculations. It is assumed that two opposite edges of the plate are hinged or have sliding fastening while the fastening of the other two edges is arbitrary. Diagrams of the problems are depicted. The question of free vibrations and plate stability is only generally described, and equations for solving the stresses arising from a trapezoidal load on a portion of a plate are worked out. L.S.

N67-20080*# Israel Program for Scientific Translations, Ltd., Jerusalem.

ON THE STATE OF MEMBRANE STRESS OF SHELLS OF REVOLUTION WITH POSITIVE CURVATURE

A. M. Kiyashko *In its* Theory of Shells and Plates 1966 p 495–499 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Integral functions of equilibrium describing the state of membrane stresses of shells of revolution formed by a second-order surface (positive curvature) are presented. Homogeneous static equations of equilibrium are worked out for the general case. Solutions are also derived for two cases of loading of a glass-shaped shell by a concentrated force, and are represented in the form of functions. L.S.

N67-20081*# Israel Program for Scientific Translations, Ltd., Jerusalem.

SOLUTION OF THE PROBLEM OF THE CYCLICALLY SYMMETRICAL DEFORMATION OF A CONIC SHELL IN DEGENERATE HYPERGEOMETRICAL FUNCTIONS

A. D. Kovalenko *In its* Theory of Shells and Plates 1966 p 500–506 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

The solution of the forces, moments, strains, and displacements occurring in the cyclical deformation of a conic shell of uniform thickness under the action of a force load and nonuniform heating (and corresponding to the distribution along the parallel of contour and surface forces and purely thermal strains according to the law $\cos k\theta$ or $\sin k\theta$ ($k=2,3$), where θ is the angle between the planes of the running and the initial meridians) is found by using hypergeometrical functions. The system of equations used in obtaining the solutions are presented. L.S.

N67-20082*# Israel Program for Scientific Translations, Ltd., Jerusalem.

EXPERIMENTAL STUDY OF THIN-WALLED STRUCTURES IN LIMITING STATES

L. A. Kolesnikov *In its* Theory of Shells and Plates 1966 p 507–513 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

An experimental study was conducted to test the accuracy of the computing models and the theoretical calculation used, and to determine the weak places in which collapse occurs and which are not susceptible to theoretical calculation by the computing model adopted. A large number of gauges were used in the experiment to measure the elongations, displacements, and stresses.

It was found that the use of the methods of mathematical statistics increases the reliability of the processing the experimental data. The limiting states (stress-strained states) are formulated in a form suitable for experimental tests, and provide a means for establishing clear algorithms for the analysis of the experimental data. Their use contributes to the automation of the data processing, and speeds up the calculations and increases their accuracy and reliability. The setting of eight-gauge rosettes makes it possible to successfully analyze membrane computing models. Author

N67-20083*# Israel Program for Scientific Translations, Ltd., Jerusalem.

STABILITY OF UNSTIFFENED AND STIFFENED LONGITUDINALLY CORRUGATED CYLINDRICAL SHELLS

G. L. Komissarova *In its* Theory of Shells and Plates 1966 p 514–521 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Differential equations of stability for longitudinally corrugated cylindrical shells of large and medium flexural rigidity in the axial direction, either stiffened or unstiffened, are solved. The results and numerical calculation of the corrugated shells by the theory of bars and by the theory of structurally orthotropic shells are compared with results from an experimental study of corrugated shells. The form and dimensions of the corrugation are depicted. The comparison indicates that the critical load found by the theory of structurally orthotropic shells is higher by 40 to 50% than the experimental value, while the critical load found by the theory of bars coincides satisfactorily with the experimental results. L.S.

N67-20084*# Israel Program for Scientific Translations, Ltd., Jerusalem.

ON THE STABILITY OF SHALLOW CYLINDRICAL SHELLS SUPPORTED ON THE INNER SURFACE BY AN ELASTIC FOUNDATION

B. A. Korbut *In its* Theory of Shells and Plates 1966 p 522–529 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Some characteristic features of large scale buckling are brought to light in the example of an elongated cylindrical panel lying on an elastic Winkler foundation. It is assumed that the panel dimension in the direction of the generator (the length) is considerably larger than the dimension in the direction of the arc (the width), thus making it possible to consider the bent surface as likewise cylindrical. The panel is hinged on fixed supports located along the generator and is subjected from the convex (outer) side to the action of a uniformly distributed pressure. The stresses in the middle surface, acting along the width, are assumed to be constant for all points of the panel. The phenomenon of snap-through is studied as a function of the foundation rigidity and the panel curvature. The problem is solved by the method of Bubnov–Galerkin in two successive approximations. The results obtained are illustrated graphically. Author

N67-20085*# Israel Program for Scientific Translations, Ltd., Jerusalem.

BENDING OF AN ELASTIC THIN PLATE SUPPORTED BY RIGID COLUMNS

A. S. Kosmodamianskii *In its* Theory of Shells and Plates 1966 p 530–537 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Systems of equations defining the bending occurring in a finite isotropic plate supported by rigid or yielding columns, under the action of a lateral load, are presented. The problem of the stressed-strained state of a plate rigidly bound to the column is treated in detail. Expressions for the boundary conditions on the rigidity clamped contours are given. Tabulated data for the values of the deflections, moments, and shearing forces at the points of the horizontal and vertical diameters of a plate with an elliptical column are given, and compared to values for the case of a plate with a circular column. Other tabulated data concerning deflections of these types of plate structures are also given. L.S.

N67-20086*# Israel Program for Scientific Translations, Ltd., Jerusalem.

CENTRAL IMPACT ON A CIRCULAR PLATE OF UNIFORM THICKNESS

V. V. Kostylev *In its* Theory of Shells and Plates 1966 p 538–544 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

The problem of determining the external forces in the case of central impact of an axisymmetrical body on a circular plate of uniform thickness with various conditions of support at the edges is treated on the basis of Timoshenko's theory. To study the phenomenon as a whole it was necessary to obtain a solution of the problem of free and forced vibrations of the plate and to study the processes accompanying impact. A table listing the conditions of support (boundary condition, frequency equation and roots, deflection mode, normal functions) for a rigidly built-in, for a simply supported, and for a free plate, is given. L.S.

N67-20087*# Israel Program for Scientific Translations, Ltd., Jerusalem.

VIBRATIONS OF A PLATE LYING ON AN ELASTIC FOUNDATION WITH AFTER EFFECT, ALLOWING FOR THE MASS OF A MOVING LOAD

Z. A. Kritsuk *In its* Theory of Shells and Plates 1966 p 545–553 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

The conditions of equilibrium, deflections, and frequencies of natural vibrations of the system, which represents the mechanical model of concrete-coated highways, airfields, and special foundations, are obtained through Volterra's relationships between the stress and strain; Galerkin's variational method; and systems of differential and integral equations, respectively. A diagram of the computing model used for the problem is depicted. L.S.

N67-20088*# Israel Program for Scientific Translations, Ltd., Jerusalem.

ON THE FLUTTER OF ELASTIC CYLINDRICAL COAXIAL SHELLS BETWEEN WHICH FLOWS A COMPRESSIBLE FLUID

E. P. Kudryavtsev *In its* Theory of Shells and Plates 1966 p 554–559 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Equations of motion for the two coaxial shells considered are given. Solutions are given and expressed through Bessel functions. The boundary conditions of the gas stream are considered. The natural frequencies (corresponding mainly to bending vibrations) are determined by a given formula, solved numerically by the method of successive approximations, and the equations are then transformed into a form suitable for graphic solution. Results determining the critical velocity of the flow are graphically represented. The results of the flutter and stability analysis indicate that in the range of values R_2/R_1 studied, the critical velocity is practically independent of the ratio R_2/R_1. At equal values of h/R the case of rigid inner shell and the case of rigid outer shell are characterized by almost equal critical velocities. In the case of not too slender shells ($h/R \geq 0.01$) the critical velocity can be found with a sufficient degree of accuracy by the Miles formula $M_{cr} = V_{min}/c_\infty + 1$ where V_{min} is the minimum propagation velocity of the elastic waves in the shell. L.S.

N67-20089*# Israel Program for Scientific Translations, Ltd., Jerusalem.

ON THE GEOMETRY OF HANGING ROOFINGS WITH A RADIAL GUY NET AND MOMENTLESS CONTOUR RING

E. N. Kuznetsov *In its* Theory of Shells and Plates 1966 p 560–567 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Mathematical relationships giving the law of loading necessary and sufficient for the equilibrium of a momentless contour ring of arbitrary shape in the case of an arbitrarily located pole of radial forces, are obtained from differential equations representing the component ring forces. The results obtained were used to determine the shape of a momentless contour ring of a uniformly loaded radial net in which the guys in the deformed state horizontally approach the net node. In another example, the outline of the momentless contour ring of a radial net with constant thrust per unit angle was determined. Expressions for the geometrical parameters of a hanging roof; and an expression for calculating the guy length through its geometrical parameters are given. L.S.

N67-20090*# Israel Program for Scientific Translations, Ltd., Jerusalem.

ON THE BEST INITIAL APPROXIMATIONS IN THE EIGENVALUES PROBLEM OF THE RITZ AND BUBNOV–GALERKIN METHODS

S. N. Kukudzhanov *In its* Theory of Shells and Plates 1966 p 568–572 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

A procedure in which the indices of the coordinate functions in the expansion terms of the Bubnov–Galerkin function are not fixed beforehand, is proposed and outlined. The procedure leads to a better approximation of the expansion terms; and considerably simplifies the solution by reducing the number of terms taken into account without impairing the accuracy of the solution (universality of the approach suggested is not claimed). L.S.

N67-20091*# Israel Program for Scientific Translations, Ltd., Jerusalem.

SOME STABILITY PROBLEMS OF SANDWICH SHELLS

L. M. Kurshin *In its* Theory of Shells and Plates 1966 p 573–579 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

The linear and nonlinear equations of simple nonshallow shells necessary for deriving the equations of a sandwich shell were obtained from the equations of the tridimensional theory of elasticity, allowing for the Kirchoff-Love hypothesis and using the same system of approximations as in the derivation of the elasticity equations. Formulas for determining the forces per unit length in the shell; the moments in the outer layers; the tensile and flexural rigidities of the outer layers; and other stability equations, are presented. Thorough calculations for the case of combined action of compression and pressure were conducted by means of computer by formulas connecting the values of the critical load parameters by the theory of shallow shells; and the results were plotted on curves suitable for practical utilization. Analysis of the results indicates that the limits of applicability of the theory of shallow shells are generally widened. It was established that the allowance for the bending moment in the outer layers is of importance when compression predominates. L.S.

N67-20092*# Israel Program for Scientific Translations, Ltd., Jerusalem.

ON THE INFLUENCE OF COMPRESSIBILITY ON THE BENDING OF ELASTO-PLASTIC PLATES

Yu. R. Lepik and L. Ya. Lukht *In its* Theory of Shells and Plates 1966 p 580:585 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

An algorithm for the rigorous allowance for the influence of compressibility on the bending of elasto-plastic plates, is developed. The basic relationships and method of solution are presented. The problem of the equilibrium (bending) of a circular plate simply supported along the contour is solved as an example. The results obtained are compared with results found by approximate methods. L.S.

N67-20093*# Israel Program for Scientific Translations, Ltd., Jerusalem.

AXISYMMETRICAL FLUTTER OF CYLINDRICAL SHELLS IN A SUPERSONIC GAS STREAM

K. K. Livanov *In its* Theory of Shells and Plates 1966 p 586–590 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

A method for solving exactly the problem of the axisymmetrical vibrations of a cylindrical shell in a supersonic stream, allowing for the inertia forces of all the displacements, is proposed. Formulas expressing the displacements, vibrations, forces, and moments, and boundary conditions are presented. The results obtained on the Strela computer, using a program based on the Galerkin method, are given in both tabular and graphic form. L.S.

N67-20094*# Israel Program for Scientific Translations, Ltd., Jerusalem.

BENDING OF FLEXIBLE PLATES BUILT-IN ECCENTRICALLY IN AN ELASTIC CONTOUR

Ya. D. Livshits *In its* Theory of Shells and Plates 1966 p 591–596 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

A system of fundamental equations of equilibrium and compatibility (Karman equations) and a system of contour equations (by the author) describing the problem of a rectangular flexible plate rigidly clamped to elastic ribs bordering it in such a way that the neutral surface of the plate is eccentric relative to the rib axes, are presented. Diagrams of the problem are given. The equations are used to solve the linear banding in the plate by means of the net method, where the unknown are the deflections and stress functions at the points within the contour, at the contour points, and at the first and second points outside the contour. This approach ensures a considerably higher accuracy than the use of various interpolative formulas for eliminating the unknowns in the points outside the contour. L.S.

N67-20095*# Israel Program for Scientific Translations, Ltd., Jerusalem.

SOME PROBLEMS OF SHELL DYNAMICS

O. V. Luzhin *In its* Theory of Shells and Plates 1966 p 595–604 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

A brief literature survey of recent studies on examinations of free vibrations of shells of revolution of various shapes, is presented. All the studies are generally based on the classic theory of calculating shell moments; the case of a cylindrical isotropic shell being most widely studied. Rigorous and approximate solutions of the problem of free vibrations are discussed. Work discussed includes the determination of the spectrum of frequencies of the free vibrations of spherical shells; the dynamics of conic shells; the dynamics of a paraboloidal shell of revolution; and shells of revolution of an arbitrary shape. A matrix analysis of problems concerning closed shells of revolution is presented. L.S

N67-20096*# Israel Program for Scientific Translations, Ltd., Jerusalem.

INFLUENCE OF THE RIGIDITY OF TRANSVERSE DIAPHRAGMS ON THE TEMPERATURE STRESSES IN THIN-WALLED SYSTEMS (SHELLS)

L. A. Maleshenko *In its* Theory of Shells and Plates 1966 p 605–613 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

An engineering method of calculating the temperature stresses in thin-walled bars and shells of closed and open profile is proposed. With this method the influence of various structural features of the system (rigidity of the transverse diaphragms, skin thickness, conditions of support, etc.) and of the parameters of a two-dimensional temperature field can be assessed relatively simply

and reliably. The longitudinal ribs are allowed for approximately by reducing the system to a structurally orthotropic one. The shell structure can be either homogeneous or made from different materials. The analysis is conducted for a system free of external forces (these are allowed for independently). The particular examples of calculations presented coincide satisfactorily with the results obtained by the method of Vlasov, Kan, and others. Author

N67-20097*# Israel Program for Scientific Translations, Ltd., Jerusalem.
APPLICATION OF THE METHOD OF ASYMPTOTIC INTEGRATION TO PROBLEMS OF SHELL VIBRATIONS
R. L. Malkina *In its* Theory of Shells and Plates 1966 p 614–619 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

The advantages of treating problems of free vibrations of shells of positive curvature by the method of asymptotic integration over other systems of equations, is demonstrated by an example with a spherical dome. It is assumed that the state of stress and strain of the shell varied considerably during the vibrations. L.S.

N67-20098*# Israel Program for Scientific Translations, Ltd., Jerusalem.
VIBRATIONS OF A SPHERICAL SHELL UNDER THE ACTION OF A CONCENTRATED FORCE
A. A. Manasyan *In its* Theory of Shells and Plates 1966 p 620–625 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

The concentrated force is considered as the limiting case of a load continuously distributed over the spherical shell surface, which tends to zero everywhere except at the zero point, where it tends to infinity. The initial equations of motion of a shell element were obtained from equilibrium equations with inertial terms added. The reduced forms after elementary transformations are presented. The solutions of the reduced form for zero initial conditions is determined. A diagram showing the equilibration of the inertia forces acting on the system by the external loads is given. The problem is solved by the Fourier method, i.e., expanding by the eigenfunctions. These are given. L.S.

N67-20099*# Israel Program for Scientific Translations, Ltd., Jerusalem.
AXISYMMETRICAL BENDING OF A THICK CIRCULAR SANDWICH PLATE
A. P. Melkonyan *In its* Theory of Shells and Plates 1966 p 626–632 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

The problem of the bending of a thick circular, sandwich plate, made of layers having different moduli of elasticity, under an arbitrary axisymmetrical load applied to the upper base is treated. The modulus of elasticity is considered as constant within the limits of each layer. It is assumed that the materials of the three layers have the same Poisson ratio. A diagram of the cylindrical system of coordinates for the problem is depicted. Mathematical relationships for the stresses, displacements, and boundary conditions involved, are presented. L.S.

N67-20100*# Israel Program for Scientific Translations, Ltd., Jerusalem.
STABILITY OF A CYLINDRICAL SHELL IMMERSED IN A RESTRICTED FLUID MEDIUM UNDER DYNAMIC LOADING
E. N. Mnev *In its* Theory of Shells and Plates 1966 p 633–639 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Mathematical relationships for solving the deflections and boundary conditions of a problem concerning the process of buckling of a thin-walled cylindrical shell immersed in a restricted fluid nonviscous medium under dynamic loading, are presented. A cylindrical system of coordinates is introduced. The results of calculations satisfactorily agree with experimental results obtained for the problem. L.S.

N67-20101*# Israel Program for Scientific Translations, Ltd., Jerusalem.
VIBRATION MODES IN THE PROBLEM OF THE SUPERSONIC FLUTTER OF PANELS
A. I. Movchan and A. A. Movchan *In its* Theory of Shells and Plates 1966 p 640–645 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Some of the characteristics of the natural modes of vibrations (flutter) common to panels of different shape in the plan, in the flow of a supersonic gas stream, are represented by simple mathematical expressions. Equations for determining eigenvalues, the boundary conditions, and the velocity of propagation of the traveling waves, are presented. Curves for some of the functions are depicted. Calculations show that for the panels of practical interest, the minimum velocity of the waves is small compared with the velocity of sound in the gas. L.S.

N67-20102*# Israel Program for Scientific Translations, Ltd., Jerusalem.
QUALITATIVE ANALYSIS OF THE MEMBRANE SOLUTION
N. F. Morozov *In its* Theory of Shells and Plates 1966 p 646–649 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

The solutions of the membrane equation of a circular thin plate for three possible boundary conditions are worked out. Several qualitative conclusions relative to the deflection functions and the stress function of the membrane can be made from the symmetrical solution. In the case of a constant positive load the function of symmetrical deflection is positive and convex. The radial and circumferential stresses in the case of symmetrical deflection and boundary conditions are positive for all points of the membrane, and the membrane is in a state of all-round extension. L.S.

N67-20103*# Israel Program for Scientific Translations, Ltd., Jerusalem.
NATURAL VIBRATIONS OF SANDWICH PLATES RECTANGULAR IN THE PLAN
V. N. Moskalenko *In its* Theory of Shells and Plates 1966 p 650–658 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

An exact solution of the dynamic equations of the theory of elasticity, and solutions based on various theories of sandwich plates, were established for one class of end conditions. The exact solution obtained was compared with the solution obtained on the strength of approximate theories, and conclusions relative to the region of application of the approximate theories considered were drawn on the basis of this comparision. The results obtained were published (reference given). Results corresponding to the second part of the report, dealing with the application of Bolotin's asymptotic method to the problem of the vibrations of sandwich plates, are presented. Author

N67-20104*# Israel Program for Scientific Translations, Ltd., Jerusalem.
ELASTIC-PLASTIC STRESSED STATE OF PLATES IN A THREE-DIMENSIONAL TEMPERATURE
I. A. Motovilovets and Yu. N. Shevchenko *In its* Theory of Shells and Plates 1966 p 659–666 (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Simultaneous action of tensile and bending loads at plastic deformation is treated for the elastic-plastic state of stress for a rapidly revolving disk of arbitrary profile placed in a nonstationary temperature field. Allowances are made for variation of temperature through the disk thickness as well as variation along the radius. Temperature field is determined by solving for heat conduction. The equations evolved are for cases of simple loading, such as (1) the proportionality of the variation of the centrifugal and surface forces and the heat load or (2) the physically nonlinear problem when loading and unloading proceed according to the same curve. The described method has been programmed for use with a digital computer. M.W.R.

N67-20105*# Israel Program for Scientific Translations, Ltd., Jerusalem.

BENDING AND STABILITY OF RECTANGULAR PLATES WEAKENED BY RECTANGULAR CUTS

Yu. N. Muzychenko *In its* Theory of Shells and Plates 1966 p 667–675 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Instead of using the method of nets to solve problems of bending and buckling of plates, equations are used in which unknown functions at the nodal points are values of the displacement function and its angles of rotation around both the x and the y axes. Boundary conditions and contours of the rectangular cuts that weaken the plates, as well as the differential equation of bending can be satisfied at every point of the plate as long as the load acting on the plate varies according to a linear law and with the contour. Conditions of equilibrium are discussed; and boundary conditions are formulated for cases when (1) the edge does not have vertical displacements, (2) is rigidly clamped, (3) is hinged, or (4) is free. Bending of a square simply-supported plate weakened by a square cut is determined under the action of moments distributed uniformly along the plate contour. Bending is also determined for a rididly-supported square plate under a load distributed uniformly along the hole contour. M.W.R.

N67-20106*# Israel Program for Scientific Translations, Ltd., Jerusalem.

ON THE DETERMINATION OF THE CRITICAL LOAD OF CONICAL AND CYLINDRICAL SHELLS

P. V. Myursepp *In its* Theory of Shells and Plates 1966 p 676–680 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Formulas are given for determining the critical load of a conical shell subjected to uniformly distributed external pressure, and expressions are derived for the critical load of short cylindrical and conical shells with built-in ends. The critical load of a short shell is somewhat larger than that of a larger cylindrical or conical shell, although the difference for the two lengths is very little when the short and medium length shells are simply-supported at their ends. With built-in ends, this is not the case; and different formulas must be used for the different length shells. A formula for determining the critical load of a truncated cone of medium length under a lateral external pressure distributed linearly along the cone generator was derived by the method of distrubances; and modifications are included for calculations with simply-supported and built-in ends. M.W.R.

N67-20107*# Israel Program for Scientific Translations, Ltd., Jerusalem.

ASYMPTOTIC THEORY OF STATICS AND DYNAMICS OF ELASTIC CIRCULAR CYLINDRICAL SHELLS AND ANALYSIS OF THE ACCURACY OF THE DIFFERENT VARIANTS OF THE KIRCHHOFF–LOVE THEORY

U. K. Nigul *In its* Theory of Shells and Plates 1966 p 681–685 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Expanded asymptotic formulas that represent the unknown magnitudes in the inner regions of elastic cylindrical shells are presented, and analysis is made of the accuracy of the Kirchhoff–Love theory and the formulas of the elementary states of stress on the basis of these asymptotic formulas. Asymptotic theory formulas are given for stress resultants, moments, transverse forces, displacements, strain components of the middle surface of the shell, and the characteristic equation. It is noted that these formulas can be simplified at the expense of an increase in errors of the resulting calculations. M.W.R.

N67-20108*# Israel Program for Scientific Translations, Ltd., Jerusalem.

SEPARATE APPLICATION OF THE MEMBRANE THEORY AND THE BENDING-MOMENT THEORY TO THE CALCULATION OF SHALLOW SHELLS

V. M. Nikireev *In its* Theory of Shells and Plates 1966 p 686–692 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

A system of equations is evolved for shallow shells by splitting the state of stress in the shell into membrane and bending states of stress. The Poisson ratio is taken as zero, the load is expanded in a trigonometric series, and deflection expressions are obtained. Three separate methods are outlined for various boundary conditions, and comparisons are made of results obtained by the approximation method described and Vlasov's general theory for shells in the form of a paraboloid and a cylinder. M.W.R.

N67-20109*# Israel Program for Scientific Translations, Ltd., Jerusalem.

NONSTATIONARY FLUTTER OF CYLINDRICAL PANELS

Yu. N. Novichkov *In its* Theory of Shells and Plates 1966 p 693–698 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

An approximate solution using the method of single-frequency vibrations is given for the nonstationary vibrations of shallow cylindrical panels in a supersonic gas stream; and the influence of various parameters on the nonstationary flutter is illustrated. Normal deflection is approximated for a cylindrical panel simply-supported on all edges, the Galerkin–Pankovich procedure is employed, the generating system splits into two conjugate systems with zero determinants, and coefficients are obtained for the expanded series. The resultant low values of the damping coefficient for the nonstationary vibrations are sufficiently close to that for stationary behavior; and the initial deviations influence the amplitude of nonstationary vibrations in the initial portion only. The nonstationary solutions corresponding to unsteady flutter are considered, and it is shown that stability of the amplitude values on the flutter line changes. M.W.R.

N67-20110*# Israel Program for Scientific Translations, Ltd., Jerusalem.

ENGINEERING METHOD OF CALCULATING LAMINATED ANISOTROPIC PLATES

E. S. Osternik and Ya. A. Barg *In its* Theory of Shells and Plates 1966 p 699–704 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Theory and calculations are discussed for bending, buckling, and vibrations of anisotropic laminated plates in relation to subassemblies of high power turbogenerators. The proposed theory permits an allowance for lateral shear without a preliminary calculation according to the classical theory. Experimental results are presented for a three-layered beam; with outer layers of steel fastened to the middle layer of plexiglas by a cold-hardening glue. Deflections were measured on nine points along the beam; and at 8 kg/cm^2, calculated deflection was 0.73 mm as compared to an actual measurement of 0.71 mm. M.W.R.

N67-20111*# Israel Program for Scientific Translations, Ltd., Jerusalem.
CALCULATING A CEILING IN THE FORM OF A SHELL RECTANGULAR IN THE PLAN
V. A. Pal'mov and A. A. Pervozvanskii *In its* Theory of Shells and Plates 1966 p 705–710 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Stresses are calculated for an elliptical paraboloid shell that is formed by cutting four vertical planes symmetrical to the parabola apex. The shell ends are connected to a side element that rests on a series of vertical columns. The asymptotic properties of the moments, shearing forces, and tangential stresses are determined; and solutions are shown for the asymptotic properties of an externally distributed load and other components. Boundary conditions are established for each of the elementary states of stress; and from these are obtained the membrane state of stress, the end effect, and the bending state. M.W.R.

N67-20112*# Israel Program for Scientific Translations, Ltd., Jerusalem.
STUDY OF THE MEMBRANE STRESSED STATE OF ELLIPSOIDAL SHELLS OF REVOLUTION WITH A REGULAR ROW OF HOLES
S. V. Pashentsev *In its* Theory of Shells and Plates 1966 p 711–717 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Stress concentrations in shells with several cuts are calculated by splitting the stressed state into a membrane state and an edge-effect state, and Hilbert's boundary value problem is obtained by specifying the normal load component. The problem formulated is then solved for the case of an elliptical shell of revolution with regular rows of holes. The Hilbert problem reduces to the case of loading a normal pressure, and the boundary value problem is solved for cyclical conditions. The initial problem is reduced to a Dirichlet problem, and the uniqueness condition is integrated to obtain the required solution. M.W.R.

N67-20113*# Israel Program for Scientific Translations, Ltd., Jerusalem.
STABILITY OF AN ELASTIC–PLASTIC CYLINDRICAL SHELL UNDER DYNAMIC LOADING
A. K. Pertsev *In its* Theory of Shells and Plates 1966 p 718–725 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Determination is made of the dangerous load, under which visually noticeable residual dents appear, for an elastic–plastic cylindrical shell. The stability of the middle portion of a fairly long shell is studied, assuming that the distance between the stiffening ribs does not decrease under dynamic loading. The edge effect is neglected, and the initial deflection of the shell coincides with the form of buckling. The relationship between the residual deflection and the maximum magnitude of the load is obtained, as is the dependence of the static critical load on the size of the initial dents. Several cases are considered to investigate the variation in dangerous loads among shells. M.W.R.

N67-20114*# Israel Program for Scientific Translations, Ltd., Jerusalem.
ON THE VIBRATIONS OF HOMOGENEOUS AND SANDWICH PLATES
G. I. Petrashen' and L. A. Molotkov *In its* Theory of Shells and Plates 1966 p 726–732 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Equations of flexural vibrations in thin homogeneous and unlimited sandwich plates with plane-parallel boundaries of separation are derived. Displacement of the points of the middle plane are considered, and it is assumed that the linear operator contains a finite number of components; and correspondence is obtained between the displacement values and the true process of vibrations of the plate as a three-dimensional elastic body. Formulas are given for the field of elastic displacements, and these are interpreted from the point of view of deformations in the plate. M.W.R.

N67-20115*# Israel Program for Scientific Translations, Ltd., Jerusalem.
REFINED SOLUTION OF THE PROBLEM OF BENDING OF ORTHOTROPIC CYLINDRICAL PANELS AND PLATES
D. V. Peshtmaldzhyan *In its* Theory of Shells and Plates 1966 p 733–738 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Finite displacements of very shallow orthotropic shells and plates at small deformations are treated on the basis of the general equations of the nonlinear theory of elasticity, keeping the nonlinear terms that contain the derivatives of the normal displacements. Deflections do not vary through the shell thickness, the shearing stresses are determined through the shell thickness, and the normal stress is determined from the linearized equilibrium equation. These fundamental relationships and the necessary equations are treated in detail. Several solutions are included for variously supported shells, and their boundary conditions are found to be qualitatively similar. M.W.R.

N67-20116*# Israel Program for Scientific Translations, Ltd., Jerusalem.
SOME DYNAMIC PROBLEMS OF THE THERMOELASTICITY OF THIN SHELLS
Ya. S. Podstrigach and R. N. Shvets *In its* Theory of Shells and Plates 1966 p 739–745 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Physical relationships are obtained for thin shells in a nonstationary temperature field that are subjected to an external load, and the fundamental equations of thermoelasticity of thin shells are presented. These equations are discussed in terms of certain rheological relationships. Examples are included of the forced vibrations of a spherical shell and of the longitudinal as axisymmetrical vibrations of a heat-insulated infinite cylindrical shell. M.W.R.

N67-20117*# Israel Program for Scientific Translations, Ltd., Jerusalem.
ON THE APPLICATION OF THE METHOD OF SUM REPRESENTATIONS TO THE NUMERICAL SOLUTION OF BIHARMONIC PROBLEMS
G. N. Polozhii and E. M. Prikhod'ko *In its* Theory of Shells and Plates 1966 p 746–752 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Modifications of sum representation formulas are given that simplify the computational scheme and reduce the amount of calculations involved in the solution of a system of linear algebraic equations with indeterminate parameters. The vectors of these parameters are determined through the boundary conditions on the vertical sides of the rectangle. Two numerical examples are presented. One requires a solution of the finite-differences biharmonic problem in a rectangle at boundary conditions at the horizontal sides. In the second example, additional parameters are added to the basic conditions set forth in the first problem. M.W.R.

N67-20118*# Israel Program for Scientific Translations, Ltd., Jerusalem.
STABILITY OF RECTANGULAR FLEXIBLE PLATES MADE FROM NONLINEARLY ELASTIC MATERIALS

V. M. Proskurina *In its* Theory of Shells and Plates 1966 p 753–760 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Critical stresses and deformation pattern after buckling of a flexible rectangular plate made from a nonlinearly elastic material are treated. All of the initial assumptions and hypotheses of the theory of lateral bending are used; and the stressed state of the plate is characterized by small elastic–plastic deformations. The plate material is considered incompressible, the loading simple, the strains active, and stress–strain relationship exponential. Equations are given for the displacements; and at a given unit compression, these can be found from the total energy of the plate. Another procedure described for determining the stability of these rectangular flexible plates is included; and, while this method involves some error, it avoids the more complex set of equations proposed by the first method. For the simplified method, the strain of a nonlinearly elastic plate can be considered in terms of some equivalent plate. It is assumed that the plate strain caused by the bending is independent of the physical properties of the material and dependent only upon the boundary conditions. M.W.R.

N67-20119*# Israel Program for Scientific Translations, Ltd., Jerusalem.

ON THE CALCULATION OF HANGING ROOFINGS

G. I. Pshenichnov *In its* Theory of Shells and Plates 1966 p 761–765 ref (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Fundamental equations are considered for the nonaxisymmetrical case of a circular hanging roof, made of two systems of prestressed shallow fibers, that is simultaneously subjected to a uniformly distributed load along with a snow load. A system of seven equations is solved to determine the stresses, and an example is included to check the section of the ropes of a hanging circular roof. The tension in the upper ropes is determined to insure the specified structure of the roof before it is subjected to a surface load. M.W.R.

N67-20120*# Israel Program for Scientific Translations, Ltd., Jerusalem.

ON THE CALCULATION OF PLATES ON AN ELASTIC FOUNDATION

G. M. Reitman *In its* Theory of Shells and Plates 1966 p 766–771 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Relationship between the contact pressure applied to an elastic foundation and the depression of the surface points is represented by a linear integral system, and two related inverse problems are solved. In one, the foundation properties are known and the kernel describing these as well as the depression surface are specified. From these data, the contact pressure is determined. In the other problem, the pressure distribution is given for a foundation for which the depressions of the surface points have been determined experimentally; the kernel representing the foundation properties must be found. M.W.R.

N67-20121*# Israel Program for Scientific Translations, Ltd., Jerusalem.

STABILITY OF REINFORCED CYLINDRICAL SHELLS UNDER AXISYMMETRICAL LOADS

K. A. Roditelev *In its* Theory of Shells and Plates 1966 p 772–777 ref (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

A nonlinear formulation of an energy method is used to determine the stability of a cylindrical shell, reinforced by stringers and enclosed by stiffeners, under axial compression with or without an internal or external pressure. Since it is assumed that skin and stringers buckle simultaneously, the problem is reduced to the study of the skin along whose contact lines are radial forces that depend on stringer rigidity. To increase the critical stress on the skin, the number of stringers must be no less than four times the number of half-waves. Determination is made of the strain energy of the middle surface at bending, the work of the external forces applied to the shell ends, the influence of internal or external pressure, and the radial forces of the stringers to the skin; as well as the minimum weight of the reinforced cylindrical shell, and the cross sections of the stringers for various conditions of end fastening. Modeling the stability of smooth cylindrical shells is considered; and theoretical data are compared with experimental results. M.W.R.

N67-20122*# Israel Program for Scientific Translations, Ltd., Jerusalem.

ON THE RIGIDITY OPERATORS OF A STIFFENED PLATE AT CREEP

M. I. Rozovskii and G. I. Bulakh *In its* Theory of Shells and Plates 1966 p 778–786 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Consideration is given to the creep at bending of a plate that is reinforced in two directions by closely-set perpendicular ribs that are symmetrical on the two sides of the middle plane. The plate is made up of isotropic homogeneous layers rigidly fastened to each other, and the rigidity operators of this stiffened plate are determined. Examples deal with (1) the deflection of an orthtropic plate, supported on all four sides, and under normal load distribution; and (2) creep of a simple rectangular plate, stiffened by ribs and with four built-in sides, that is bent by a uniformly distributed normal load. Rheological parameters are presented for lead supporting ribs and rubber outer layers as well as for simple copper plate. M.W.R.

N67-20123*# Israel Program for Scientific Translations, Ltd., Jerusalem.

ON THE BENDING OF LENGTHY ANISOTROPIC PLATES MOVING IN A GAS AT CONSTANT SUPERSONIC VELOCITY

V. S. Serkisyan *In its* Theory of Shells and Plates 1966 p 787–796 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

A small-parameter method is used to obtain an approximate solution for the bending of a long, narrow anisotropic plate of arbitrary symmetrical shape and clamped by the edges moving in gas at constant supersonic velocity. A power series of small parameter is introduced into the region contour equation, and the system of equations is evolved. Attention is given to the action of an aerostatic load on an infinite strip, elliptical plate, and streamlined profile. Using these examples, proof is offered for the assymptotic convergence in the Poincare sense of the power series. M.W.R.

N67-20124*# Israel Program for Scientific Translations, Ltd., Jerusalem.

USE OF THE METHOD OF DYNAMIC RIGIDITIES FOR CALCULATING THE FREQUENCIES OF NATURAL VIBRATIONS OF BUILT-UP SHELLS

I. E. Sakharov *In its* Theory of Shells and Plates 1966 797–805 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Frequencies of natural vibrations in built-up shells are determined by using a method of dynamic rigidities; and by splitting the shell into several simple types. Forces and moments that vary harmonically are introduced, and the forced vibrations are solved for each of the simple shells subjected to distributed bending moments at the ends. The dynamic rigidities, formed from the values for the displacements at the ends, are a ratio of the amplitudes of the forces to the amplitudes of the displacement caused by them. The natural vibrations equation is obtained by using the

equality of the interactions and the conditions of strain compatability. Details are included for determining the dynamic rigidities of cylindrical and spherical shells and annular plates, all under bending moments at the ends; and an example shows how the vibrations frequency of a built-up shell is determined. M.W.R.

N67-20125*# Israel Program for Scientific Translations, Ltd., Jerusalem.

GENERALIZED PROBLEMS OF THE WATER HAMMER IN AN ELASTIC CONDUIT

I. T. Selezov and S. N. Nikulinskaya *In its* Theory of Shells and Plates 1966 p 806–811 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Propagations of small disturbances are treated for a system consisting of a conduit and the liquid that fills it. Two differential hyperbolic equations are used to describe conduit motion, and an acoustic approximation is used to study the hydrodynamic effects. Differential equations of motion are given for a liquid-filled circular cylindrical shell, and the action of the shearing forces on the separation surface between the liquid and shell are neglected. Examination of the solution for the displacements indicates that the denominator of the integrand has an infinite number of roots; and since all of the roots lie on the real axis of a complex plane, the internal integral of solution is represented as an infinite sum of the residuals. M.W.R.

N67-20126*# Israel Program for Scientific Translations, Ltd., Jerusalem.

ON THE INFLUENCE OF CREEP ON THE STATE OF THIN SANDWICH SHELLS

Ya. G. Skomorovskii *In its* Theory of Shells and Plates 1966 p 812–817 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Influence of creep on reinforced shells, particularly those of concrete, is treated; and a model is proposed that treats shells as isotropic homogeneous bodies that possess linear creep, and are reinforced by fittings in either one or two directions. The model permits creep data to be obtained without introducing average rheological characteristics of the reinforced structures themselves. By transforming the equations for shell theory and the boundary conditions according to Laplace–Carson, the transforms are found; an inversion formula is used to find the components of the stresses, strains, and displacements; and equations are evolved for thin sandwich plates. In isotropic and orthotropic reinforced shells at stationary boundary conditions, the creep causes a redistribution of the internal forces produced by an external load. The creep of concrete causes a redistribution of stresses and leads to an increase in stresses in the reinforcing layer and a decrease in the concrete itself. M.W.R.

N67-20127*# Israel Program for Scientific Translations, Ltd., Jerusalem.

FUNDAMENTAL EQUATIONS OF THE SEMIMEMBRANE NONLINEAR THEORY OF PRISMATIC SHELLS AND FOLDS

I. N. Slezinger *In its* Theory of Shells and Plates 1966 p 818–825 (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Karman's system of nonlinear equations is applied to a prismatically folded shell of average length that consists of a finite number of thin rectangular plates. The load applied to the fold is large so that the deformation is considerable. Vlasov's semimembrane nonlinear theory is used, and the arbitrary functions and integration constants are determined from the conditions of adjacent plate connections, and the boundary conditions at the lateral and extreme longitudinal edges of the fold. Approximations are also determined for the conditions of fastening and loading of the lateral edges of the fold. The results obtained can be used for studying prismatic shells and folds in which all the static and kinematic factors of deformation are of importance. M.W.R.

N67-20128*# Israel Program for Scientific Translations, Ltd., Jerusalem.

VIBRATIONS AND STABILITY OF ANISOTROPIC AND SANDWICH CYLINDRICAL SHELLS OF ARBITRARY CROSS SECTION

B. I. Slepov *In its* Theory of Shells and Plates 1966 p 826–834 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Free flexural vibrations and stability are considered for a simple anisotropic shell in the form of an elliptic cylinder, supported by end sections and loaded by a uniformly distributed pressure. A sandwich elliptical shell with rigid incompressible filler is also investigated, and linear approximations are given for the frequency of the flexural vibrations and the critical pressure. For the first problem, the equations of motion for a cylindrical shell of arbitrary cross section are used; the tangential inertia forces are neglected; and the necessary formulation is detailed. The results obtained for the rigid filler can be used for a light filler by neglecting the tensile and flexural rigidities of the filler. The procedures used for solving both problems can, under specified conditions, be used for circular shells of arbitrary cross section. M.W.R.

N67-20129*# Israel Program for Scientific Translations, Ltd., Jerusalem.

COMPRESSION AND FLEXURE OF HYPERBOLIC SHELLS

K. V. Solyanik-Krassa *In its* Theory of Shells and Plates 1966 p 835–841 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Two terms of a Fourier series, the free term and the term containing the meridional coordinate, are used to determine the load on shells shaped as hollow single-cavity hyperbolas of revolution. The load corresponding to the first term is axisymmetrical and produces, therefore, axisymmetrical deformation of the shell; while the load corresponding to the second term causes a general bending. For the first case, solutions can be found by either one or two harmonic functions. For shell bending, the boundary conditions are simplified as in the first problem; and the stresses and displacements of deformation can be represented through the derivatives of three functions, each of which is defined by a differential equation. In both problems, all of the boundary conditions cannot be satisfied exactly, and so approximations are used. M.W.R.

N67-20130*# Israel Program for Scientific Translations, Ltd., Jerusalem.

EXPERIMENTAL INVESTIGATION OF CYLINDRICAL AND SPHERICAL REINFORCED-CONCRETE SHELLS

S. I. Stel'Makh and T. K. Avdeev *In its* Theory of Shells and Plates 1966 p 842–849 (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Strength and rigidity of a reinforced concrete shallow cylindrical panel-shell for roofs of industrial buildings were determined; as were effects of precompressing the outermost shell elements on the stresses, ultimate carrying capacity of the cylindrical slab, and zone where the edge stresses act. Edge effect decompressed the diaphragms and edge elements; and, before ultimate failure, the cylindrical shell surface becomes a double-negative curvature. If the load is further increased, this equilibrium shape becomes a suspended system with considerable load-carrying capacity and with deformations that are elastic-plastic. A precast reinforced concrete spherical shell for use in floors in industrial buildings gave a clear indication of the edge effect of tangential shear between the spherical slab and the diaphragms that caused shearing of joints at the edges and gradual separation of the spherical parts of the slab from the diaphragms. The edge elements are mainly in tension and display insignificant deflections in the vertical plane. M.W.R.

N67-20131*# Israel Program for Scientific Translations, Ltd., Jerusalem.

THE LIMITING STATE OF THIN-WALLED SHAPES IN BIAXIAL BENDING WITH TORSION

A. I. Strel'bitskaya *In its* Theory of Shells and Plates 1966 p 850–856 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Relationships are established between the forces causing normal stresses and the known formulas for calculating ultimate loads; and experimental data are presented for channel beams subjected to external loads. A computational method is evolved that can also produce equations for the limiting state of other sections subjected to biaxial flexure with torsion. Theoretical and experimental limiting loads are found to be in satisfactory agreement. The spreading of the yield zone over the flange at its free edge is dependent on the angle at which the external forces are applied, and it is noted that the vertical component of deflection varies inversely with the angle at which the force acts, while the horizontal component varies directly. Change in the angle of twist is a function of the eccentricity of the force plane relative to one of the poles and of the load size. M.W.R.

N67-20132*# Israel Program for Scientific Translations, Ltd., Jerusalem.

NATURAL VIBRATIONS AND STABILITY OF RECTANGULAR PLATES OF VARIABLE THICKNESS

V. G. Tret'yak *In its* Theory of Shells and Plates 1966 p 857–866 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

A linear formulation is extended to the calculation of natural vibrations and stability of rectangular plates with (1) thickness constant or varying on only one direction and (2) for various boundary conditions. The plate material is assumed to be ideally elastic and homogeneous, and the structure used is one having the stressed state of an ordinary thin-walled beam of constant cross section so that all the beam-like strips separated by planes perpendicular to the x-axis are equally deformed. The different boundary conditions will affect deformation. The method presented for determining the natural vibrations of the thin shell is then applied to the calculation of plate stability under different boundary conditions. A graph depicts the curves for plates of uniform thickness with built-in, supported, or free edges. M.W.R.

N67-20133*# Israel Program for Scientific Translations, Ltd., Jerusalem.

THERMAL STRESSES IN AN ANISOTROPIC CIRCULAR CYLINDRICAL VAULT

A. I. Uzdalev *In its* Theory of Shells and Plates 1966 p 867–873 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

The two-dimensional problem of thermoelasticity of an infinite orthotropic cylindrical vault is considered, and stresses in the vault due to the temperature field are determined. The elastic and thermal characteristics of the material are independent of the temperature, and the deformations are assumed to be small. Distribution of the temperature stresses are determined for three cases: (1) The temperature on the internal surface and at the ends of the vault is constant, but the temperature of the external surface varies. (2) The internal surface is thermally insulated, a constant temperature is maintained at the ends, and the temperature on the external surface varies. (3) The temperature on the internal and external surface is constant, and the ends are heat-insulated. A vault in a nonstationary stressed state is also considered, and a temperature function is determined. M.W.R.

N67-20134*# Israel Program for Scientific Translations, Ltd., Jerusalem.

SOME PROBLEMS OF THE EQUILIBRIUM OF ORTHOTROPIC CYLINDRICAL SHELLS AT LARGE DEFORMATIONS

I. I. Fedik *In its* Theory of Shells and Plates 1966 p 874–881 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

The membrane stresses are treated for orthotropic cylindrical shells with rigid bottoms at a linear stress–true strain relationship. It is assumed that the shell material permits very large deformations. Equilibrium equations are shown for a cylindrical shell before deformation, and the relationships between the stresses and the true strains are written in a form similar to Hooke's Law. Equations are then evolved for a family of ellipses, and several practical examples are illustrated. Determination of the largest possible load under which the shell will remain stable is made. M.W.R.

N67-20135*# Israel Program for Scientific Translations, Ltd., Jerusalem.

USE OF ELECTRONIC DIGITAL COMPUTERS IN STRENGTH CALCULATION OF THIN-WALLED AIRCRAFT STRUCTURES

N. V. Khlebutin *In its* Theory of Shells and Plates 1966 p 882–887 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

A first approximation is outlined for the complex solution of several interconnected problems of the force-transmitting members of thin-walled aircraft structures. In treating the case of strength calculation at static loading, equations are evolved for a thin-walled bar with variable cross section. Equilibrium equations for the internal and external forces acting on the bar are given, and an oblique system of coordinates used for the skin of a bar with rigid cross section permits determination of the stress and strain in the bar. A beam-theory hypothesis is mentioned in this connection, as are some of the computer programs that have been developed. M.W.R.

N67-20136*# Israel Program for Scientific Translations, Ltd., Jerusalem.

STRESS CONCENTRATION IN A THIN PLATE WEAKENED BY AN INFINITE NUMBER OF CIRCULAR HOLES UNDER ELASTIC–PLASTIC STRAINS

I. Yu. Khoma *In its* Theory of Shells and Plates 1966 p 888–893 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

An approximation method as well as exact expressions are used to determine the stress concentrations in thin plates weakened by elastic–plastic strains. There is an infinite number of identical holes along the x-axis of the plate. Stress components are found by introducing a biharmonic function and a transformation. Formulas for finding these stress components are included, and some values are tabulated. M.W.R.

N67-20137*# Israel Program for Scientific Translations, Ltd., Jerusalem.

INTEGRAL-DIFFERENTIAL EQUATIONS OF PLATES WHOSE MATERIAL BEHAVES ACCORDING TO LINEAR RHEOLOGICAL RELATIONSHIPS

L. P. Khoroshun *In its* Theory of Shells and Plates 1966 p 894–898 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Thermodynamic methods of irreversible processes are used to obtain integral differential equations for plates whose materials exhibit linear rheological relationships. The strains are expressed and the deflection equations are given. Vibrations of a hinged rectangular plate are considered; and formulas are included for steady forced vibrations, amplitude, and phase shift. M.W.R.

N67-20138*# Israel Program for Scientific Translations, Ltd., Jerusalem.
STUDY OF THE STRESSED AND STRAINED STATE OF A PHYSICALLY NONLINEARLY ELASTIC PLATE WITH REINFORCED CIRCULAR HOLE
I. A. Taurpal *In its* Theory of Shells and Plates 1966 p 899–906 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Small deformations are considered for the stress–strain relationship of an axisymmetrical nonlinear elastic plate with a reinforced hole; and the variation of stress is tabulated as a function of external load for various cases of reinforcement. Expressions are given for the stress function for the zero, first, and second approximations. The basic quasi-linear equation contains one small parameter, and the solution is represented as a power series. Nonhomogeneous biharmonic equations are obtained for determining higher approximations; and when these are used with specified boundary conditions, the biharmonic functions of lower approximations can be found. Conditions that must be satisfied by the first-approximation function deal with both the contour and the connections. A copper plate with a soldered steel washer is used to determine the stress concentration in the first approximation; and the cases of a flexible, rigid, and solid elastic washer are treated separately. M.W.R.

N67-20139*# Israel Program for Scientific Translations, Ltd., Jerusalem.
CALCULATION OF A RIBBED TOROIDAL SHELL UNDER A SYMMETRICAL LOAD
V. A. Shamina *In its* Theory of Shells and Plates 1966 p 907–911 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

A symmetrically loaded circular toroidal shell with identical meridional ribs of uniform cross section is considered. These ribs are close to each other and located at the same angle around the shell. A model of structural anistropy is used that consists of replacing the orginal shell with an equivalent smooth orthotropic shell. Asymptotic methods are considered applicable to the solution. A specific solution is included for a circular toroidal shell for which the area occupied by the ribs is small as compared to the total shell. For the ribbed toroidal shell, the solution is approximately the same as for a smooth shell. Formulas are included for determining the basic stresses in the external fibers and the circumference of the shell. M.W.R.

N67-20140*# Israel Program for Scientific Translations, Ltd., Jerusalem.
CALCULATING ARCH DAMS
G. S. Shakhromanov *In its* Theory of Shells and Plates 1966 p 912–918 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Several approximation methods are discussed that were used in the design of shells for hydroelectric power plant dams. In the first approximation, circumferential stresses in the dams were determined by membrane theory for a thin-walled cylinder; and the pure arch principle was used to allow for actual boundary conditions, temperature stresses, and other computational factors. Transition from one-dimensional to the two-dimensional problem was realized by taking the distribution of the external load between the arches and the wall. The calculation was reduced to an approximate integration of the bent axis of a cantilever beam of variable rigidity on an elastic foundation. The same procedure was followed in obtaining basic equations for sloping dam shells of conical and spherical contours; and equations are also included for concrete dams built on the block system in order to stabilize slump strains. Normal deflections at the crest level of the central cantilever of the Inguri (USSR) dam are compared for the various methods of calculation. M.W.R.

N67-20141*# Israel Program for Scientific Translations, Ltd., Jerusalem.
REFINING THE LINEAR MOMENT THEORY OF THIN SHELLS
M. P. Sheremet'ev and E. I. Lun' *In its* Theory of Shells and Plates 1966 p 919–924 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Strain components on the middle surface of a thin shell are determined according to a hypothesis that assumes that the position of the normal to the middle surface remains straight during deformation, does not suffer extensions and compressions, and does not remain perpendicular to the middle surface after the deformation. The use of this hypothesis relative to the normal element frees the formulation of inner contradictions. The variational principles of the theory of elasticity are transferred to the theory of shells, and the problems of stress concentrations in the shell can be formulated more rigorously. A resolving equation is included for a spherical shell. M.W.R.

N67-20142*# Israel Program for Scientific Translations, Ltd., Jerusalem.
DYNAMICS OF ELASTIC AND ELASTIC–VISCOUS SHELLS FILLED WITH AN IDEAL LIQUID
Yu. S. Shkenev *In its* Theory of Shells and Plates 1966 p 925–935 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

The vibrations of elastic and elastic–viscous cylindrical shells partially filled with ideal liquids are considered. The hypotheses of the nonlinear theory of shells are used in solving the nonlinear problem of the vibrations of such a liquid-filled shell. The frequencies of the small coupled vibrations of the shell and the liquid, the frequencies of the nonlinear vibrations, and the critical frequencies of the exciting loads are determined. Author

N67-20143*# Israel Program for Scientific Translations, Ltd., Jerusalem.
ON THE CRITERION OF DYNAMIC STABILITY OF SHALLOW SHELLS OF REVOLUTION
L. I. Shkutin *In its* Theory of Shells and Plates 1966 p 936–941 refs (See N67-20021 09-32) CFSTI: HC $3.00/MF $0.65

Consideration is given to the case of a solid shallow shell of revolution whose meridian is described by an exponential function at arbitrary elastic clamping of the edge. An axisymmetrical deformation is used; and, by neglecting the inertial forces in the radial direction, the equation is given for the force function and the dimensionless potential energy. The equation for the middle surface of the shell is given, the post-buckling shape of the deflection is considered, and the initial state of equilibrium is found. Numerical calculations were conducted for conical and spherical shells with edges that were clamped, simply supported, restrained, and rigidly supported. These results are tabulated, and it is seen that the restriction of the radial displacement of the edge causes a considerable increase of the critical value of the kinetic energy. M.W.R.

N67-20171* Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
A MODAL COMBINATION PROGRAM FOR DYNAMIC ANALYSIS OF STRUCTURES
R. M. Bamford 15 Aug. 1966 50 p
(Contract NAS7-100)
(NASA-CR-82877; JPL-TM-33-290) CFSTI: $3.00 CSCL 20K

A method of determining the response of composite structures subjected to a sinusoidal forcing function is developed. The method uses characteristic rigid body and elastic deflected shapes of the components. The input required and limitations of a program using the method are stated. A sample problem is used to compare results with other methods. Author

N67-20247*# Syracuse Univ. Research Inst., N. Y. Applied Mechanics Lab.

ON THE DYNAMIC STABILITY OF ECCENTRICALLY REINFORCED CIRCULAR CYLINDRICAL SHELLS Technical Report, Sep. 1, 1965–Jan. 31, 1967

Werner K. Dietz 31 Jan. 1967 190 p refs

(Grant NsG-627)

(NASA-CR-66313; SURI-1620-1245-60) CFSTI: HC $3.00/MF $0.65 CSCL 20K

An analytical investigation of dynamic buckling of eccentrically reinforced circular cylindrical shells is presented. The stringer and ring stiffeners are assumed to be closely spaced, and general instability is investigated by an equivalent shell approach in that the reinforcement effects are smeared-out over their spacing distances. A new set of field equations (equilibrium and compatibility) is derived on the basis of large deflection theory. The theory is applied to a clamped reinforced shell which is loaded axially by a controlled rate of endshortening. The concept of stiffener location effectiveness is introduced within the scope of linear classical theory and the assumption of equal mode numbers for both reinforcement locations. Some of the major conclusions were that for Card's stringer shell rotatory inertia could be neglected in determining the critical dynamic buckling load. As expected, the magnitude of V_0 for constant rate of endshortening plays an important role. The size of the imperfection amplitudes affects the critical dynamic buckling load drastically. The effect of an exponentially decaying rate of endshortening is to reduce the critical dynamic buckling load. S.P.

N67-20259 Lockheed Missiles and Space Co., Sunnyvale, Calif.

AXISYMMETRIC STRAIN OF A RIB-REINFORCED CYLINDRICAL SHELL

P. A. Zhilin [1966] 5 p Transl. into ENGLISH from Mekh. Tverdogo Tel. (USSR), No. 5, 1966 p 139–142

CFSTI: HC $3.00

A cylindrical shell reinforced by ribs separated by an arbitrary spacing and with different geometric and elastic characteristics is considered. The solution is constructed on the basis of the Steklov–Fubini method; and equilibrium equations of a ribbed shell are presented. The method described can be extended to the general case of nonsymmetric strain of a cylindrical shell and an arbitrary shell of revolution reinforced by ribs, since the Steklov–Fubini method is applicable for systems with variable coefficients. S.P.

N67-20275*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

CONSIDERATIONS AND PHILOSOPHY OF GROUND WINDS CRITERIA FORMULATION

William W. Vaughan *In its* Aero-Astrodyn. Res. Rev. No. 5 15 Oct. 1966 p 146–157 refs (See N67-20261 09-34)

The various practical design and operational considerations involved in establishing ground winds criteria for aerospace vehicle developments are presented. The concept of exposure period probabilities in terms of risk to vehicles exposed to wind loading during operations is considered. Applications of extreme value statistics to wind design criteria and the use of spectral methods to represent the time-dependence structure of ground winds are discussed. Future needs for inputs in vehicle designs are outlined in the discussion. Author

N67-20276* National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

ON DYNAMIC RESPONSE OF A RECTANGULAR PLATE TO A SERIES OF MOVING LOADS

Frank C. Liu *In its* Aero-Astrodyn. Res. Rev. No. 5 15 Oct. 1966 p 158–164 refs (See N67-20261 09-34) CFSTI: HC $3.00

This paper deals with an elastic rectangular plate with all edges clamped and subjected to a series of evenly spaced moving loads. Two types of loads are treated; one, a uniformly distributed pressure over a fractional length of the plate and the other, an impulsive load. The loads are assumed to be uniform across the plate. The solution of the partial differential equation of vibration of plate is assumed in the form of a double series with the generalized coordinates solved by using the Laplace transform method. Viscous damping is included. Based on a two-term approximation, the steady-state dynamic response of the plate is obtained in analytical form from which the upper bounds of the maximum deflection and maximum bending stress are formulated. Numerical examples are given to illustrate the effect of thickness of plate, aspect ratio and velocity of loads on the dynamic response. Three types of resonance conditions are derived. Author

N67-20336 Royal Aircraft Establishment, Farnborough (England).

THE USE OF AERODYNAMICS IN STRUCTURAL ENGINEERING

J. Ackeret Oct. 1966 34 p refs Transl. into ENGLISH from Z. Flugwiss. (Brunswick, W. Germany), v. 13, no. 4, Apr. 1965

(RAE-LIB-TRANS-1185) CFSTI: HC $3.00

The effect of wind pressures on structures is considered. Some examples of modern exhibition architecture and typical wind damage are shown. The theories of wind pressure are discussed with reference to Prandtl's work. Some examples are shown of model testing in wind tunnels. The establishment of a European Institute to study these problems is suggested. Author

N67-20358# California Univ., Berkeley. Div. of Applied Mechanics.

MICROPOLAR AND DIRECTOR THEORIES OF PLATES

A. E. Green (Newcastle Univ.) and P. M. Naghdi Aug. 1966 40 p

(Contract Nonr-222(69))

(AM-66-12; AD-644185) CFSTI: HC $3.00/MF $0.65

After discussing the relationship between general theories based on dipolar displacement and micropolar displacement and the relations of these to a theory with a simple dipolar displacement (i.e., full displacement gradient), the remainder of the paper is concerned with linear theories of elastic plates in the presence of micropolar and director displacements. Using a method of asymptotic expansion, plate equations are derived from the three-dimensional equations of both the linearized theory of micropolar elasticity and the linearized theory of directors for an elastic body. The equations resulting from the latter derivation completely agree with those obtained previously for an elastic Cosserat plate. Author (TAB)

N67-20360# California Inst. of Tech., Pasadena. Graduate Aeronautical Labs.

RESEARCH ON NONLINEAR PROBLEMS IN STRUCTURAL DYNAMICS Final Report, 1 Jul. 1964–30 Sep. 1966

Y. C. Fung 30 Sep. 1966 20 p refs

(Contract AF 49(638)-1364)

(AFOSR-66-2724; AD-644520) CFSTI: HC $3.00/MF $0.65

A brief summary of the research work is presented. The main accomplishments are listed under (1) supersonic panel flutter of cylindrical shells, (2) liquid-solid interaction in the dynamics of a large elastic container (3) nonlinear continuum mechanics problems in bioengineering. Author (TAB)

33 THERMODYNAMICS AND COMBUSTION

Includes ablation, cooling, heating, heat transfer, thermal balance, and other thermal effects; and combustion theory. For related information see also: 12 Fluid Mechanics; and 27 Propellants.

N67-19418*# AiResearch Mfg. Co., Los Angeles, Calif.
RESEARCH STUDY ON INSTRUMENT UNIT THERMAL CONDITIONING HEAT SINK CONCEPTS Quarterly Progress Report, Jun. 1–Aug. 31, 1966
D. W. Graumann 9 Sep. 1966 24 p *ref*
(Contract NAS8-11291)
(NASA-CR-82794; Rept.-66-1174; QPR-2) CFSTI: HC $3.00/MF $0.65 CSCL 13A

Progress is reported in the development of two modules. Research on a water boiler heat sink module included testing of wick heat transfer, wick performance, and wicking height. Metal and nonmetal wicks were tested. A breakthrough analysis was performed on a water sublimator heat sink module, and capillary tubes were tested to verify analytical predictions. The effects of pore exit sharpness and contact angle on breakthrough pressure were determined. Porous plates were bench tested, and tabulated test results are presented for several specimens. K.W.

N67-19486 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
CALCULATION OF GEOMETRY OF EQUIDISTANT MOVING CONTOURS
A. F. Dregalin *In its* Aviation Eng., Vol. 7, No. 3 28 Sep. 1966 p 39–46 refs (See N67-19481 09-34) CFSTI: HC $3.00

An algorithm is given for computer calculation of various geometric configurations of equidistant moving contours. Both areas and perimeters can be computed for any type of rectangular or circular configuration by the proposed method, and appropriate equations are included for each type. Attention is given to the determination of the limits of integration and control of qualitiative changes of contour, as well as to corrections for the size of distances between elements of the contour. M.W.R.

N67-19487 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
THE INFLUENCE OF TEMPERATURE, PRESSURE AND COEFFICIENT OF EXCESS OF AIR PROCEEDING INTO A CALORIMETER ON CALORICITY OF KEROSENE
V. M. Dorofeyev *In its* Aviation Eng., Vol. 7, No. 3 28 Sep. 1966 p 47–52 ref (See N67-19481 09-34) CFSTI: HC $3.00

The caloricity of kerosene is discussed in terms of its dependence on temperature, pressure, and the excess of air entering the calorimeter. If the temperature of the air going into the calorimeter is greater than that of the critical temperature, caloricity is not dependent upon either the pressure or the coefficient of excess air. The discussion includes applications to the thermodynamics of air breathing jet engines as well as calorimetry. M.W.R.

N67-19489 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
DISTRIBUTION OF TEMPERATURE ALONG THE PROFILE OF A COOLED TURBINE BLADE WITH HEAT-INSULATED EDGES
V. I. Lokay *In its* Aviation Eng., Vol. 7, No. 3 28 Sep. 1966 p 63–71 refs (See N67-19481 09-34) CFSTI: HC $3.00

Approximate relationships are discussed that permit calculation of temperature distribution along the profile of a thin-walled hollow turbine blade, with self-insulated edges, that is cooled from within. Temperature fields around the inlet and outlet edges of the profile are found separately, and details for these determinations are included. These basic equations are modified for an edge with constant thickness, for triangular and trapezoidal edges, and for the temperature distribution along the concave part and the back of the profile. M.W.R.

N67-19494 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
DETERMINATION OF COEFFICIENTS OF HEAT RADIATION IN A PIPE ACCORDING TO DISTRIBUTION OF TEMPERATURES ON THE CONTOUR OF ITS LONGITUDINAL SECTION
V. K. Shchukin *In its* Aviation Eng., Vol. 7, No. 3 28 Sep. 1966 p 105–114 refs (See N67-19481 09-34) CFSTI: HC $3.00

Heat radiation of a liquid in a pipe with an axisymmetrical temperature field is discussed in terms of temperature effect on the shape of the longitudinal section of the pipe. Boundary conditions are considered, as is convergence of series for a pipe with heat-insulated ends with and without internal heat sources in the wall. It is assumed that convergence of series will not limit the application of the procedure, which is considered applicable for the study of heat radiation during external longitudinal flow around pipes. M.W.R.

N67-19496 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
INVESTIGATION OF DISTRIBUTION OF TEMPERATURE ALONG THE PROFILE OF A BUSHING BLADE
A. G. Zenukov *In its* Aviation Eng., Vol. 7, No. 3 28 Sep. 1966 p 121–128 refs (See N67-19481 09-34) CFSTI: HC $3.00

Attention is given to the determination of blade design methods for organizing flow of air coolant along the profile of a bushing blade to permit an optimal thermal state. Blade design diagrams indicate that definite turbine operating conditions can be set to insure optimum thermal conditions. A thermal insulating covering on the outlet edge of one of the blades reduces temperature by 70 to 100°C and produces these optimal conditions. Another design displays temperature distributions that are close to optimum, although some technological difficulties are connected with its manufacture. M.W.R.

N67-19497 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
APPROXIMATE METHOD OF CALCULATION OF A THERMAL INSULATION LAYER WITH THE CONSIDERATION OF RADIATION
G. A. Matuzok *In its* Aviation Eng., Vol. 7, No. 3 28 Sep. 1966 p 129–135 refs (See N67-19481 09-34) CFSTI: HC $3.00

Approximations are considered for calculating the heating capacity and thermal properties of a nonstationary field of an insulation plate whose internal surface has ideal heat insulation and on whose external surface there is a convective heat exchange with the environment. Equations are evolved for two stages of the heating process: the first corresponds to the time during which the change in temperature field will extend along the entire thickness of the insulation, and the second is characterized by a change in temperature field of the plate itself. M.W.R.

N67-18516# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

A NEW METHOD OF SOLVING PROBLEMS OF THERMAL CONDUCTIVITY FOR BODIES OF ROTATION

V. I. Makhovikov 27 Sep. 1966 10 p refs Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Energ. i Transp. (Moscow), no. 5, 1965 p 151–154

(FTD-HT-66-453; TT-67-60306; AD-644068) CFSTI: HC $3.00/MF $0.65

A method is proposed for solving problems of stationary thermal conductivity for a body of rotation that allows the use of the well studied examples of the solution of flat problems for harmonic functions when the boundary conditions on the surface of the body are satisfied. The axisymmetric problem is examined in detail. Author (TAB)

N67-19557# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.

ON DETONATION IN A GAS HEATED BY A SHOCK WAVE

R. I. Soloukhin 3 Aug. 1966 20 p refs Transl. into ENGLISH from Zh. Prik. Mekhan. i Techn. Fiz. (Moscow), no. 4, 1964 p 40–48

(Contract NOw-62-0604-c)

(TG-230-T494; TT-66-62472; AD-640609) CFSTI: HC $3.00/MF $0.65

The initiation and characteristics of detonations in gas mixtures heated to high temperatures by a shock wave are observed experimentally at low pressures. Numerical calculations of the reaction kinetics of hydrogen-oxygen mixtures highly diluted with argon were confirmed. Vibrationless stable detonation may occur. The calculated characteristics of such detonation agree with the experimental values. It is still impossible to determine the effect of preheating on reaction initiation mechanisms in high temperature mixtures. Author (TAB)

N67-19592*# General Electric Co., San Jose, Calif. Atomic Products Div.

MASS TRANSFER STUDIES IN SODIUM

R. W. Lockhart *In* AEC AEC–NASA Liquid Metals Inform. Meeting 23 Apr. 1965 p 101–107 refs (See N67-19581 09-17) CFSTI: HC $3.00/MF $0.65

Test conditions are reviewed, along with the operation of the six test loops. Summary information is presented on the various experiments, the long exposure corrosion rate data are plotted, and the corrosion rate prediction formula is given. Among the results reported are: (1) Exposure effects or corrosion rates are location- and geometry-dependent. (2) Long term corrosion rates appear to be linear with respect to time and independent of alloy combinations. (3) Metallic surface layers exposed to 1100° to 1200°F sodium develop a perturbed composition which is sensitive to the oxygen plugging temperature. (4) Steady state corrosion appears to be stoichiometric and independent of the perturbed layer composition. (5) Chemical analysis of the saturated metallic impurities in the sodium are 800 to 1000 times as great as calculated from corrosion rate data, which suggests an alloy or oxide activation potential mass transfer model rather than a metallic solubility model. M.G.J.

N67-19609*# Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.

T-111 CESIUM NATURAL CONVECTION LOOP

R. L. Ammon, R. T. Begley, and R. L. Eichinger *In* AEC AEC–NASA Liquid Metals Inform. Meeting 23 Apr. 1965 p 359–373 refs (See N67-19581 09-17) CFSTI: HC $3.00/MF $0.65

This paper describes the construction, operation, and analysis of a cesium natural convection loop. The purpose of this program was to evaluate the corrosion resistance of T-111 (Ta-8W-2Hf) in cesium liquid and vapor, and to acquire operating experience on a high temperature two-phase cesium loop. Preliminary studies of the compatability of T-111 with Cs were accomplished by means of refluxing capsule tests at a maximum temperature of 2500°F. Metallographic examination of T-111 capsules which operated 100 and 750 hours indicated no significant corrosion effects. Author

N67-19625# Atomic Energy Commission, Washington, D. C.

SMOOTHED THERMOCOUPLE TABLES OF EXTENDED SIGNIFICANCE

R. K. Adams and E. G. Davieson *In its* High Temp. Thermometry Mar. 1966 3 p refs (See N67-19621 09-22) CFSTI: HC $3.00/MF $0.65

A summary of two publications containing smoothed thermocouple tables which are expressed to a significance of 0.001 μv and which match the National Bureau of Standards (NBS) tables everywhere to within the NBS rounding; is reported. Emphasized is the usefulness of these tables for laboratory experiments involving small ΔT measurements where precision thermometry is required. An example of the smoothed table for $Pt/Pt_{90}Rh_{10}$ is compared with the NBS table $W_{97}Re_3/W_{75}Re_{25}$; $Au_{97.9}Co_{2.1}$/Cu (cryogenic); Constant/Copper (cryogenic); Alumel/Chromel (cryogenic); Constantan (JN)/Iron (JP) (cryogenic); and Constantan (YN)/Iron (YP) (cryogenic). S.C.W.

N67-19695# Naval Weapons Evaluation Facility, Albuquerque, N. Mex.

ANALYSIS OF HEAT TRANSFER IN A THREE-LAYER SLAB: CONSTANT FLUX ON ONE SURFACE AND ZERO FLUX ON THE OTHER SURFACE

Eva M. Thorn 31 Oct. 1966 62 p refs

(Rept.-1002; AD-642635) CFSTI: HC $3.00/MF $0.65

The one-dimensional time-dependent equation of heat conduction is solved for an infinite three-layer slab. The conventional Laplace transform technique is not employed, but rather the method of separation of variables is applied with a novel eigenfunction expansion of the initial temperature distribution. Boundary conditions considered are constant flux on one side of the slab and zero flux on the other. Author (TAB)

N67-19706# Instituto Nacional de Technica Aeronautica, Madrid (Spain).

ON THE INFLUENCE OF CHEMICAL KINETICS ON THE COMBUSTION OF FUEL DROPLETS

Carlos Sanchez Tarifa Copenhagen, Congr. Intern. des Machines a Combust., 1962 25 p refs

(Grant AF-EOAR-62-90)

(AD-642670) CFSTI: HC $3.00/MF $0.65

The influence of chemical kinetics on the combustion of fuel droplets is studied by means of a theoretical model of the process which considers spherical symmetry and quasi-stationary conditions. Chemical kinetics is approximated by means of an overall reaction rate of the nth order. Results are expressed as a function of the product of the pressure to the n/2th order times the droplet radius. It is shown that there exists a minimum value of such product under which an individual droplet cannot sustain a flame. An experimental investigation was also carried out, by burning in air at variable pressure fuel droplets suspended of thin quartz fibres. The laws of variation of both flame and droplet diameter as functions of time were obtained as well as the minimum values of the droplet diameters for combustion as a function of pressure. It is shown that all experimental results are in excellent qualitative agreement with those predicted by theory. Author (TAB)

N67-19762# Toronto Univ. (Ontario). Inst. for Aerospace Studies.
PROPERTIES OF CHAPMAN-JOUGUET DETONATIONS IN STOICHIOMETRIC HYDROGEN–OXYGEN MIXTURES DILUTED WITH HELIUM AND HYDROGEN
Andre Benoit Dec. 1966 133 p refs
(Contract AF 33(615)-2766)
(UTIAS-TN-104; AD-644805) CFSTI: HC $3.00/MF $0.65

The thermodynamic and composition data behind a Chapman-Jouguet detonation wave propagating into a mixture of stoichiometric oxygen-hydrogen diluted with helium and/or hydrogen are computed assuming thermodynamic equilibrium. Results are presented for hydrogen and helium dilutions respectively. The effects of initial conditions, namely dilution, pressure and temperature, are studied numerically and some approximate relations are provided for the purpose of practical interpolation. The study includes a comparison with the thermodynamic data of the final gaseous products of an equivalent constant volume combustion. The results are presented numerically and graphically for dilutions varying from 0 to 67 percent, initial pressures ranging from 0.01 to 1000 atmospheres and initial temperatures from 200 to 700 degrees Kelvin. Author (TAB)

N67-19763# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio.
AN INVESTIGATION OF THE BEHAVIOR OF A DETONATION WAVE IN A FLOWING COMBUSTIBLE MIXTURE Final Report, Aug. 1964–Jun. 1966
William W. McKenna (Ph.D. Thesis—Ohio State Univ.) ARL, Jun. 1966 133 p refs
(ARL-66-0112; AD-642240) CFSTI: HC $3.00/MF $0.65

The study of detonation waves in a flowing combustible mixture of gas could lead to a better understanding of combustion instability in rocket motors and to possible application to supersonic combustion. Apparatus was designed to measure the relative wave velocity and to photograph the wave profile as a fully developed detonation wave propagated against a flow of stoichiometric mixture of hydrogen-oxygen gases. The Mach number of the flowing gas was varied from 0.14 to 4. The subsonic flow results indicated that the absolute detonation wave velocity relative to the gas was independent of the speed of the flowing gas. But, the supersonic flow results indicated a strong wave which was contributed to the particular pressure profile in the tube during the supersonic flows. The schlieren photographs of the wave indicated propagation into the boundary layer and a convex curvature of the complete wave front was observed in the Mach 4 flow. Velocity measurements indicated that the detonation wave was steady but it is believed that retonation waves were observed in some experiments. Author (TAB)

N67-19797# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
CALCULATION OF THE TEMPERATURE OF A TWO-LAYER WALL OF A SECTION OF A STRUCTURE UNDER EXTERNAL HEAT-EXCHANGE CONDITIONS THAT VARY WITH TIME
V. F. Vorob'yev 2 Sep. 1966 13 p refs Transl. into ENGLISH from Prikl. Mekhan. Tekhn. Fiz. (USSR), v. 1, no. 7, 1965 p 14–20
(FTD-HT-66-485; TT-67-60352; AD-644638) CFSTI: HC $3.00/MF $0.65

The problem of determining the temperature field in a two-layer wall of a section of a structure that is filled with liquid or gas is examined. On a definite part of the surface of the section, where intensive heat exchange with the external medium occurs, the coefficient of heat exchange from forced convection and the temperature of the external medium are calculated by known time functions. The radiation of heat from the external surface into the external space is calculated. An approximate analytical solution obtained on the basis of a number of assumptions is presented in tabulated functions of the arguments of time and the coordinate along the wall thickness. Author (TAB)

N67-19798# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
AERODYNAMIC AND HEAT EXCHANGE STUDIES IN AN ANNULAR CHANNEL WITH AN INNER ROTATING CYLINDER
V. N. Zmeykov and B. P. Ustimenko 20 Sep. 1966 38 p refs Transl. into ENGLISH from Probl. Teploenerg. i Prikl. Teplofiz. (USSR), no. 1, 1964 p 148–172
(FTD-TT-65-2026; TT-67-60385; AD-644802) CFSTI: HC $3.00/MF $0.65

Detailed experimental data are given on the velocity and temperature distributions, friction and heat transfer in an annular channel with an inner rotating cylinder. New formulas are given which describe the velocity distribution and the friction coefficient. A scheme of calculating the heat transfer is described which is based upon an application of the hydrodynamic theory of heat exchange. The theoretical results are compared with experimental ones. Author (TAB)

N67-19806# Ballistic Research Labs., Aberdeen Proving Ground, Md.
A NUMERICAL SOLUTION TO AN ABLATION PROBLEM WITH POSSIBLE LASER APPLICATIONS
James G. Faller Oct. 1966 28 p refs
(BRL-R-1342; AD-644734) CFSTI: HC $3.00/MF $0.65

The problem of an ablating solid of limited extent under an applied non-uniform heat input is solved numerically, and the solution is compared in certain limiting cases with results from the exact analytical equations. Further, the usefulness of this model in predicting the depth of hole made in materials by a laser beam is explored. Author (TAB)

N67-19820# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
EXPERIMENTAL STUDY OF VORTEX FLOW IN A CYLINDER
Edward Joseph Palanek (M.S. Thesis) Mar. 1966 172 p refs
(GAM-66A/AE/66-6; AD-642354) CFSTI: HC $3.00/MF $0.65

The major objectives of the study were to determine the effects of variable injection angle and mass flow on heat transfer and flow characteristics in a vortex field confined in a centrally heated cylindrical tube, and to evaluate hot-wire probe techniques in similar conditions. Maximum vortex strength and heat transfer were generated at a 35 degree injection angle and produced a film heat transfer coefficient 2.3 times greater than that for axial flow at the same mass flow. Hot-wire results correlated reasonably well in similar flow conditions and indicated future possibilities in arc-stabilization studies. Author (TAB)

N67-19843# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
TURBOCOOLER
G. I. Voronin, V. I. Slotin et al 16 Sep. 1966 6 p Transl. into ENGLISH from Soviet Patent no. 171006 (Appl. no. 890090/40-23, 27 Mar. 1964) 2 p
(FTD-HT-66-100; AD-644639) CFSTI: HC $3.00/MF $0.65

The object of the invention is a turbocooler for systems of conditioning air in hermetically sealed sections of flying apparatuses which contains operating wheels of a turbine and a blower turning on gas bearings. An immovable axis is designed as

a hollow with a supporting disk in the middle part, serving together with the face surfaces of the wheels of the turbine and the blower as a supporting bearing, to which gas is conducted from input piping of the turbine through a hollow axis. Author (TAB)

N67-19844# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.
HANDBOOK OF SUPERSONIC AERODYNAMICS. SECTIONS 13 AND 14: VISCOSITY AND HEAT TRANSFER EFFECTS
R. E. Wilson (Naval Ordnance Lab.) 1 Aug. 1966 355 p refs
(Contract NOw-62-0604-c)
(NAVORD-1488; Vol. 5; AD-644217) GPO: HC $2.75; CFSTI: MF $0.65

Contents: Boundary-layer equations; Solutions to the flat plate boundary-layer equations; Boundary-layer growth on two-dimensional and axisymmetric bodies; Boundary-layer transition; Effect of roughness on the flat plate turbulent boundary layer; Heat transfer. TAB

N67-19871*# Lockheed Missiles and Space Co., Sunnyvale, Calif. Aerospace Sciences Lab.
EMISSIVITY COATINGS FOR LOW-TEMPERATURE SPACE RADIATORS Quarterly Progress Report, 10 Oct.–31 Dec. 1966
J. R. Grammer 31 Dec. 1966 35 p refs
(Contract NAS3-7630)
(NASA-CR-72161; QPR-6) CFSTI: HC $3.00/MF $0.65 CSCL 20M

Research activities during October through December, 1966, centered on the evaluation of aluminum silicate/potassium silicate coatings at 534°K, and zinc oxide/potassium silicate coatings at 534°K, and at 422°K. Samples were exposed for up to 500-hr duration to ultraviolet radiation at a 1-sun level from a xenon source at a vacuum of 10^{-7} torr or less, and at maximum intended operating temperatures. Of the two coatings tested at 534°K, the zinc oxide/potassium silicate system was the more stable; change in solar absorptance was 0.13 for this system, as compared with 0.30 for the zirconium silicate/potassium silicate coatings. Degradation remained essentially constant after 300 hr of exposure. G.G.

N67-19881*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
A STUDY OF ARTIFICIAL METEORS AS ABLATORS
Charles E. Shepard, John W. Vorreiter, Howard A. Stine, and Warren Winovich Washington, NASA, Mar. 1967 35 p refs Presented at the 5th Congr. of the Intern. Council of the Aeron. Sci., London, 12–16 Sep. 1966
(NASA-TN-D-3740) CFSTI: HC $3.00/MF $0.65 CSCL 20M

Photographic observations of meteors could provide more reliable information on the meteoroid hazard to space travel if meteor ablation and radiation phenomena were better understood. Static tests in an ultrahigh-enthalpy plasma jet reveal that artificial meteors of gabbro or basalt ablate and radiate similarly to samples cut from natural stone meteorites. Likewise, steel specimens duplicate the behavior of natural iron meteorite material. During ablation the comparable materials grow in frontal area, decrease in average density, and emit light in the same manner. Author

N67-19928* Heat Technology Lab., Inc., Huntsville, Ala.
FEASIBILITY STUDY OF VACUUM PRESSURE MEASUREMENT BENEATH AND WITHIN BATTENS OF HIGH PERFORMANCE INSULATION Final Report
W. W. Youngblood and L. H. Usher 18 Jan. 1967 82 p refs
(Contract NAS8-18040)
(NASA-CR-82938; HTL-TR-37) CFSTI: HC $3.00 CSCL 20M

The total pressure beneath battens of high performance insulation on an inflight cryogenic storage experiment tank can be continuously monitored from launch using any one of three suggested measurement systems. The recommended system consists of a temperature compensated thermocouple gauge for the total pressure range of 1×10^{-3} torr to 30 torr and specially constructed Phillips or Penning cold cathode gauge for the total pressure range of 1×10^{-7} torr to 25×10^{-3} torr. Laboratory experiments demonstrated that large pressure differentials exist across multi-layered aluminized Mylar insulations and that outgassing effects of the insulation are significant. Several difficulties anticipated in making these pressure measurements are discussed in detail and recommendations are presented for the additional studies desirable in finalizing the flight instrumentation system. Author

N67-20000*# TRW Systems, Redondo Beach, Calif.
INVESTIGATION OF HIGH-SPEED IMPACT PHENOMENA (IV) Final Report
J. F. Friichtenicht, D. O. Hansen, A. S. Hersh, J. C. Slattery, and E. Tagliaferri Dec. 1966 12 p
(Contract NASw-1336)
(NASA-CR-82920; TRW-05320-6006-R000) CFSTI: HC $3.00/MF $0.50 CSCL 20M

Studies were devoted to the interaction of high velocity particles with gaseous targets using the electrostatic particle accelerator. Emphasis was placed on laboratory simulation of meteor phenomena; and the first direct experimental measurements of meteor ionization and luminous efficiencies were completed. The initial measurement of ionizing efficiency which used iron particles and air targets was expanded to encompass a variety of target gases. Finally, drag coefficients were precisely measured under free-molecule flow conditions for relatively low velocity particles. As a result of this experiment, a modified free-molecule drag model was developed. Supplementary data are included in the form of abstracts on; ionization probability of iron particles at meteoric velocities, meteor luminous efficiency measurement, ionization from Fe atoms incident on various gas targets, and drag coefficient of microscopic spheres in free molecular flow. S.P.

N67-20009# National Bureau of Standards, Washington, D. C.
TABLE OF THERMODYNAMIC PROPERTIES AND CHEMICAL COMPOSITION OF ARGON IN CHEMICAL EQUILIBRIUM INCLUDING SECOND VIRIAL CORRECTIONS FROM 2400°K TO 35,000°K
Joseph Hilsenrath, Carla G. Messina, and Max Klein Arnold AF Station, Tenn., Arnold Eng. Develop. Center, Dec. 1966 129 p refs
(AEDC-TR-66-248; AD-644081) CFSTI: HC $3.00/MF $0.65

Tables for the thermodynamic properties for argon are presented which take into account the effect of dissociation and ionization and the limiting-law Debye-Huckel and second virial corrections upon the thermodynamic properties and the equilibrium compositions. Values are tabulated from 2400K in steps of 200K to 20,000K and from 20,000K in steps of 500K to 35,000K at conformation spacing in the log density/density at standard conditions values. From 0.00001 to 10 to the 2-4th power x normal density the equilibrium composition is computed for six species: A, A(+), A(++), A(+++), A(++++), and E(-). The values tabulated include the compressibility factor Z = P x V/RT; the dimensionless functions for internal energy, E/RT; enthalpy, H/RT; entropy, S/R; log10 P (atm); and Z^* = Sigma(Ci). The underlying equations and the input data are discussed briefly. The effects of the real-gas corrections on the equilibrium properties are illustrated graphically. The equilibrium composition is given for selected temperatures over the tabulated density range. The wide range of temperatures and densities over which the thermodynamic properties were tabulated make the tables useful in a variety of engineering design and test programs, and in scientific research and development. Author (TAB)

N67-20169*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
THE UTILIZATION OF POWDERED METALS AS FUELS IN THE ATMOSPHERES OF VENUS, EARTH, AND MARS
R. A. Rhein 28 Feb. 1967 15 p refs
(Contract NAS7-100)
(NASA-CR-82878; JPL-TR-32-1073) CFSTI: HC $3.00/MF $0.65 CSCL 21B

The ignition temperatures of a number of powdered metals have been measured in air, in a simulated Venus atmosphere, and in a simulated Mars atmosphere. Each atmosphere was thought to consist of mixtures of argon, carbon dioxide, and nitrogen. This study was conducted to show that the atmospheres of the planets Mars and Venus might be utilized as sources of oxidizers for chemical energy. The heat liberated from the combustion of lithium, beryllium, and boron in the simulated Venus and Mars atmospheres was calculated from the compositions of the products formed from the combustion of these metals in the simulated Venus and Mars atmospheres. The product compositions were determined by chemical analysis. Author

N67-20211# Aerojet-General Nucleonics, San Ramon, Calif.
THERMODYNAMIC AND TRANSPORT PROPERTIES OF CESIUM AND RUBIDIUM VISCOSITY OF LIQUID CESIUM AND RUBIDIUM. VOLUME 3: VISCOSITY OF LIQUID CESIUM AND RUBIDIUM
P. Y. Achener and M. R. Boyer Sep. 1966 45 p refs
(Contract AT(04-3)-368)
(AGN-8192, Vol. 3) CFSTI: HC $3.00/MF $0.65

The viscosity of liquid cesium and rubidium was determined at temperatures from the melting points up to 1070°C. The experimental method involved the use of an oscillating cylinder viscometer. The equations proposed for the absolute viscosity of cesium and rubidium are, respectively: $\log_{10}\mu = 104.013/T - 0.59911 \log_{10}T + 1.8781$ and $\log_{10}\mu = 62.2374/T - 0.78639 \log_{10}T + 2.4459$ where μ is in millipoises and T in degrees Kelvin. Author (NSA)

N67-20264*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
OPTICAL METHODS FOR REMOTE SENSING OF LOCAL THERMODYNAMIC PROPERTIES AND TURBULENCE
F. R. Krause, A. J. Montgomery, William O. Davies (IIT Res. Inst., Chicago, Ill.), and M. J. Fisher *In its* Aero-Astrodyn. Res. Rev. No. 5 15 Oct. 1966 p 24–36 refs (See N67-20261 09-34)
(Contracts NAS8-11258; NAS8-20107)

Four different optical methods for the remote sensing of local thermodynamic properties and turbulence in model flows or in the atmosphere are described and compared. The Abel integral and zone approximation methods are most appropriate for the measurement of mean values, while the cross-beam correlation technique primarily measures fluctuating quantities. Viewing techniques are restricted to applications in which a flow contains particulate matter or a tracer is introduced. Author

N67-20298# European Space Technology Center, Paris (France).
THE THERMAL ENVIRONMENT IN SPACE
L.A. Husian (European Space Technol. Noordwijk, Netherlands) Dec. 1966 26 p refs Presented at the ESRO Summer School, Oxford, 28 Aug. 1964
(ESRO-TM-49) CFSTI: HC $3.00/MF $0.65

The nature of the various factors contributing to the thermal environment experienced by satellites in space is discussed, e.g. heat sink, solar and earth radiation. The contribution of these factors to the thermal balance and their effect on spacecraft design are examined. Author (ESRO)

N67-20318# Gt. Brit. Ministry of Aviation, London.
THE INITIATION OF IGNITION IN COMPOSITE SOLID ROCKET PROPELLANTS
H. Osada and S. Kakinouchi Nov. 1966 18 p refs Transl. into ENGLISH from Kogyo Kayaku Kyokaishi (Tokyo), v. 26, no. 4, 1965 p 200–211
(TIL/T-5669) CFSTI: HC $3.00/MF $0.65

The initiation was studied by means of thermogravimetry, differential thermal analysis, X-ray diffraction, gas chromatography and mass spectrum. It was concluded that: (1) NH_4ClO_4 crystal structure from alkaline solution is normal but defective from acid or aqueous solution; (2) for equivalent sizes the normal structure has the faster rate of heat decomposition; (3) $HClO_4$ accelerates the decomposition; and (4) powdering eliminates defective structure and produces $HClO_4$ in the NH_4ClO_4. Effects of NiO and thicokol resins were also studied, and their interaction with NH_4ClO_4. Author

N67-20328# Aeronautical Research Council (Gt. Brit.)
THE HEATING OF AIR BY "DARK" DISCHARGE
J. E. Hesselgreaves, T. R. F. Nonweiler, and T. R. Foord (Glasgow Univ.) 25 May 1966 38 p refs
(Contract PD/48/05)
(ARC-28046) CFSTI: HC $3.00/MF $0.65

A theoretical and experimental investigation is made of the heating of air by means of a dark or Townsend discharge, the intended application being the heating of the working fluid of a hypersonic intermittent wind tunnel. Results are presented of experiments at atmospheric pressure designed to determine the efficiency of energy conversion and to test the validity of the theoretical assumptions. The theory is used to predict the performance of a small heater working at 15 atmospheres pressure. Author

N67-20380# Case Inst. of Tech., Cleveland, Ohio. Engineering Div.
APPARATUS FOR THE INVESTIGATION OF INSTABILITIES IN GAS COOLED HEAT EXCHANGER TUBES
Edward R. Kolbe (M.S. Thesis) Nov. 1966 55 p refs
(Grant NGR-36-003-064)
(NASA-CR-82980; FTAS/TR-66-13) CFSTI: HC $3.00/MF $0.65 CSCL 20M

Steady-state gas flow characteristics in slender heated tubes indicate that for a given pressure drop, a unique flow rate does not exist. Of the two or possibly three flow rates, the one having a negative rate of change of pressure drop with flow rate at constant heat input is unstable. For gases this condition usually occurs when the flow in tube is laminar. Details of the design, construction, and initial tests of apparatus for the investigation of the laminar instability problem are presented. Results of previous work on both the steady-state and dynamical problem are discussed and used in the prediction of experimental results for helium in an electrically-heated .094" ID × 54" tube. For a gas cooled passage it is indicated that there are only two flow rates for a given pressure drop and heat input to the gas, one on a negatively sloped branch and the other on a positively sloped branch. The data recorded during initial testing indicated operating points on both branches of the steady-state curve. Author

34 GENERAL

Includes reports of a broad nature related to industrial applications and technology, and to basic research; defense aspects; law and related legal matters; and legislative hearings and documents.

N67-19403# Toronto Univ. (Ontario). Inst. for Aerospace Studies.
ANNUAL PROGRESS REPORT, 1966
Oct. 1966 248 p refs

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11. INDUSTRIAL AND ARCHITECTURAL AERODYNAMICS p 83–84 (See N67-19414 09-32)

N67-19481 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
AVIATION ENGINEERING, VOLUME 7, NO. 3
28 Sep. 1966 150 p refs Transl. into ENGLISH of Aviatsionnaya Tekhnika (Kazan), v. 7, no. 3, 1964 p 1–132
(FTD-MT-64-363; TT-67-60308; AD-644068) CFSTI: HC $3.00

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7. CALCULATION OF LOSSES UPON SUDDEN EXPANSION OF FLOW A. Ye. Zaryankin and L. V. Milkhnenkov p 53–61 refs (See N67-19488 09-12)
8. DISTRIBUTION OF TEMPERATURE ALONG THE PROFILE OF A COOLED TURBINE BLADE WITH HEAT-INSULATED EDGES V. I. Lokay p 63–71 refs (See N67-19489 09-33)
9. THE PROBLEM OF NATURAL VIBRATIONS OF BLADES OF AN AXIAL COMPRESSOR I. M. Movshovich p 73–80 ref (See N67-19490 09-32)
10. VIBRATIONS OF A CYLINDRICAL SHELL PARTIALLY FILLED BY FLUID V. F. Natushkin and I. S. Rakhimov p 81–85 refs (See N67-19491 09-32)
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14. DETERMINATION OF AXIAL CONSUMPTION OF FLUID DURING ROTATIONS OF SHAFT A. I. Belousov p 115–119 refs (See N67-19495 09-15)
15. INVESTIGATION OF DISTRIBUTION OF TEMPERATURE ALONG THE PROFILE OF A BUSHING BLADE A. G. Zenukov p 121–128 refs (See N67-19496 09-33)
16. APPROXIMATE METHOD OF CALCULATION OF A THERMAL INSULATION LAYER WITH THE CONSIDERATION OF RADIATION G. A. Matuzok p 129–135 refs (See N67-194097 09-33)
17. A MORE PRECISE DEFINITION OF THE CONCEPT "TECHNOLOGICAL CHARACTER OF DESIGNS" I. T. Belyakov p 137–141 refs (See N67-19498 09-02)

N67-19553# RAND Corp., Santa Monica, Calif.
ROCKETS ON GUARD FOR PEACE [RAKETY NA STRAZHE MIRA]
V. Datsenko, M. Mryakin, and N. Izmailov 29 Jul. 1966 11 p Transl. into ENGLISH from Ogonek (Moscow), no. 25, 20 Jun. 1965 p 4–7
(LT-66-46; TT-65-63816; AD-638174) CFSTI: HC $3.00/MF $0.65

The article is a journalistic sequel to a military parade that took place in Moscow on Red Square 9 May 1965, the twentieth anniversary of what the Soviets call the day of victory over Germany in the Great Patriotic War. It contains film clips of a variety of weapons taken from a special documentary film prepared for this occasion. This film was shown in America on the ABC television network under the title 'Soviet Missile Arsenal' with English commentary by Jules Bergman, ABC Science Editor. The film purportedly showed for the first time Soviet ICBMS silo-launched, polaris-type sub-launched missiles, the SAM interceptions of aircraft and missiles, including one nuclear interception of an ICBM. The purpose of this translation is to make available not only the English text of the article but also the accompanying illustrations.
Author (TAB)

N67-19669# RAND Corp., Santa Monica, Calif.
SOME STATISTICAL METHODS FOR MAINTENANCE ANALYSIS
Anders Sweetland Apr. 1966 52 p refs
(Contract AF 49(638)-1700; Proj. RAND)
(RM-4443-PR; AD-632994) CFSTI: HC $3.00/MF $0.65

Presented is a translation of an elementary statistics text into the context of weapon-system analysis. It is designed to supplement the statistical training of maintenance personnel of the Reports and Analysis section at the base level. Most of the examples are from SACR 66-7, but the methods are applicable to data generated by other major Commands. Since most maintenance measures are frequency counts, emphasis is on dealing with this kind of data. Three principal maintenance problems are considered: (1) how alert is affecting the breakrate; (2) what effect the 100-hour periodic is having on subsequent missions; and (3) whether any bomb-nav systems are deteriorating. The answers demonstrate the use of the chi-square test and simple analysis of variance.
Author (TAB)

N67-19804# Western Reserve Univ., Cleveland, Ohio.
THE DESIGN AND IMPLEMENTATION OF A NARRATIVE DATA REDUCTION SYSTEM
Andrew J. Singer (Haskins Labs.) Oct. 1966 57 p refs Sponsored in part by Gen. Analystics Corp.
(Grants AF-AFOSR-403-64; NIH FRS-003; PHS FR-5596)
(AFOSR-66-2878; AD-644205) CFSTI: HC $3.00/MF $0.65

The design and implementation are described of a system for collecting and analyzing narrative textual data. The data base consisted of clinical reports on which several normalizing rules with respect to language and format were imposed. Machine processing procedures consist of two basic units: a file maintenance package that performs all operations necessary for the creation, duplication, and updating of the files, and a Data Analysis and Reduction System (DARES) that implements text reduction and data analysis languages and the operating environment for them. The two languages have similar structures but differ in their interpretation. The basic compiler consists of three interpreters, the parser that performs syntactic and lexical analysis of the source language, a generator that defines rules by which source elements are translated to equivalent object forms, and a messager that operates on erroneous statements in the source string. The prototype system was implemented on a CDC 160A computer. The compiler processes source strings at about 280 characters/sec; the interpreters require 2000 words of storage, the remaining 6000 words being used for definition and symbol tables. Sample specifications and outputs are given. In this typical example, about 450 pages of text were processed against 14 questions in slightly less than 35 minutes. Aspects of use of the system by persons without technical computer backgrounds are discussed.
Author (TAB)

N67-19956*# Washington Univ., St. Louis, Mo. Dept. of Economics.
THE ROLE OF ECONOMICS IN LONG-RANGE PLANNING FOR AN AEROSPACE COMPANY
Murray L. Weidenbaum Jan. 1967 38 p refs *Its* Working Paper No. 6701
(Grant NsG-342)
(NASA-CR-82943) CFSTI: HC $3.00/MF $0.65 CSCL 05A

The discussion focuses on the applications of economic analysis in private corporations, notably those in the aerospace industry. Emphasis is placed on business management because that aspect of company activity provides an excellent framework for surveying the various potential applications of economic theory, methodology, and statistics to the business firm. Five phases of the business planning process are treated to indicate the actual and possible influence of economic factors and contributions of economic analysis of each of them. These include: 1) setting forth the external environment in which the business enterprise will be operating during the planning period, 2) establishing long term goals and objectives for the enterprise, 3) formulating the key programs and major undertakings on which the company will embark, 4) analyzing the capability of and resources available to the enterprise, and 5) evaluating the adequacy of the developmental programs to meet the goals and objectives in the anticipated environment. Finally, the role of the business economist is defined.
R.N.A.

N67-19988*# California Univ., Los Angeles. Inst. of Government and Public Affairs.
ANALYSIS OF NASA POSTCARD SUBCONTRACT DATA
Marvin Hoffenberg Dec. 1966 165 p refs
(Grant NGR-05-007-047)
(NASA-CR-82928) CFSTI: HC $3.00/MF $0.65 CSCL 05D

The purpose of this study is to measure the differential impacts of civilian space activity on the various subnational areas of the United States, and to improve data collection and processing for such analyses. Discussed are ways by which NASA affects regions and why regions compete for space technology tasks. Comments are made on the instruments through which NASA affects geographic areas. The central part of the report is a review of the subcontractor reporting system, the so-called postal card system, which is followed by an analysis of this data. The analyses are mainly designed for profile tracing, and some applications are discussed. A preliminary design is established for the information output requirement to study regional implications of NASA programs, and a methodology is developed for linking conjectures on regional impacts with alternative future NASA outlays; i.e., specific types of economic data on past programs are integrated into the NASA planning-programming-budgeting system. Suggestions are presented for improving NASA's economic fact gathering.
K.W.

N67-20261*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
AERO-ASTRODYNAMICS RESEARCH REVIEW NO. 5
William D. Murphree, ed. 15 Oct. 1966 205 p refs
(NASA-TM-X-53568) CFSTI: HC $3.00/MF $0.65 CSCL 01A

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2. ACOUSTIC AND HEAT TRANSFER ASPECTS OF LAUNCH VEHICLE TURBULENCE F. Krause and W. K. Dahm p 14–23 (See N67-20263 09-01)

3. OPTICAL METHODS FOR REMOTE SENSING OF LOCAL THERMODYNAMIC PROPERTIES AND TURBULENCE A. J. Montgomery, W. O. Davies, M. J. Fisher (IIT Res. Inst.), and F. R. Krause p 24–36 refs (See N67-20264 09-33)

4. ATMOSPHERIC APPLICATIONS OF THE CROSS-BEAM TECHNIQUE W. O. Davies and R. W. Deuel (IIT Res. Inst.) p 38–46 refs (See N67-20265 09-13)

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6. RLC SYNTHESIS OF TRANSFER FUNCTIONS J. W. Fontenot (Northrop Space Labs.) and D. H. Townsend p 70–79 refs (See N67-20267 09-10)

7. A SIMPLE FEEDBACK LAW FOR A COOPERATIVE RENDEZVOUS PROBLEM T. E. Carter p 80–83 refs (See N67-20268 09-10)

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12. SOLAR PRESSURE PERTURBATIONS ON THE ORBIT OF A FLAT REFLECTOR S. Perrine p 130–136 refs (See N67-20273 09-30)

13. LUNAR SURFACE: AN INTERPRETATION BASED ON PHOTOGRAPHIC DATA FROM THE RUSSIAN LUNA IX AND UNITED STATES SURVEYOR I O. H. Vaughan p 138–144 refs (See N67-20274 09-30)

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N67-20344# Picatinny Arsenal, Dover, N. J. Plastics Technical Evaluation Center.

DIRECTORY IN PLASTICS–KNOWLEDGEABLE GOVERNMENT PERSONNEL (REVISED)

Norman E. Beach Sep 1966 154 p Supersedes Plastec-5A (Plastec-5B; Plastec-5A; AD-642574) CFSTI: HC $3.00/MF $0.65

The directory provides a means for the rapid identification and contacting of those personnel within the Department of Defense who are knowledgeable in the various areas of plastics development, manufacture and uses. This revision has been expanded beyond the Departments of the Army, Navy and Air Force, to include the Departments of the Treasury; Commerce; Agriculture; the Interior; Health, Education and Welfare; and Housing and Urban Development. Included also are Government-funded information agencies, and the National Aeronautics and Space Administration.

Author (TAB)

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